

Energie door plaattektoniek

Olie en gas

KNAG dag 2010 Zwolle

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Met dank aan prof. H. Doust (VU/Shell)



Overview

Algemene principes achter olie en gas

Source rock (moedergesteente)

Migratie (primair)

Reservoir

Traps

Opsporing

Regionale voorbeelden

(Nederland, Midden-Oosten)

Toekomst

Rol van plaattektoniek

Moedergesteente

Koolstofrijke afzetting waaruit
koolwaterstoffen kunnen ontstaan

Type I – Algen en plankton
(marien, olie!)

Type II – Bacterien
(marien, vaak met zwavel)



Type III – Planten (op het land, steenkool en
gas)

Plankton

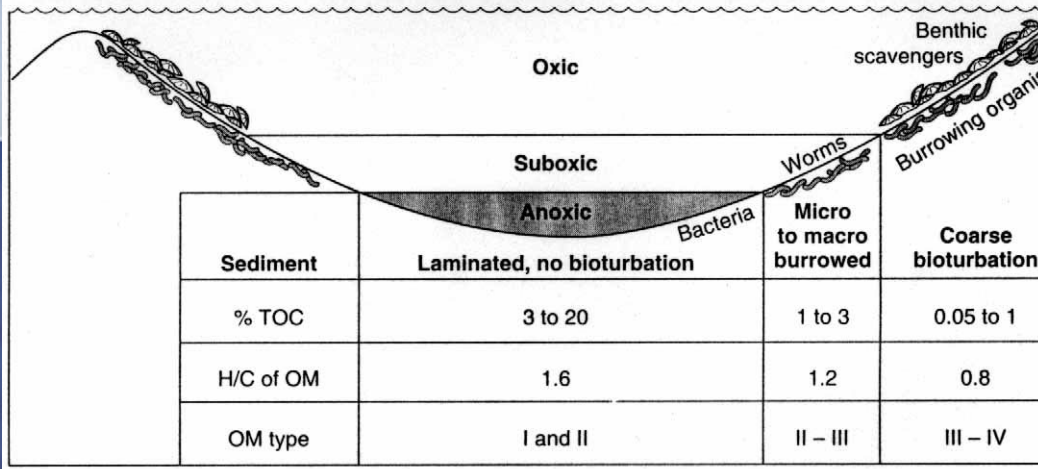
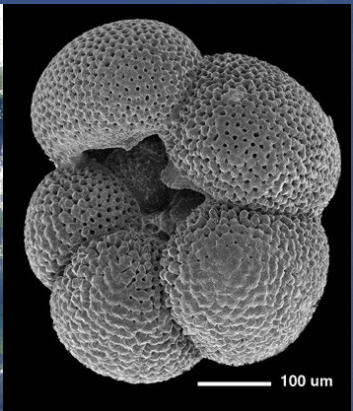
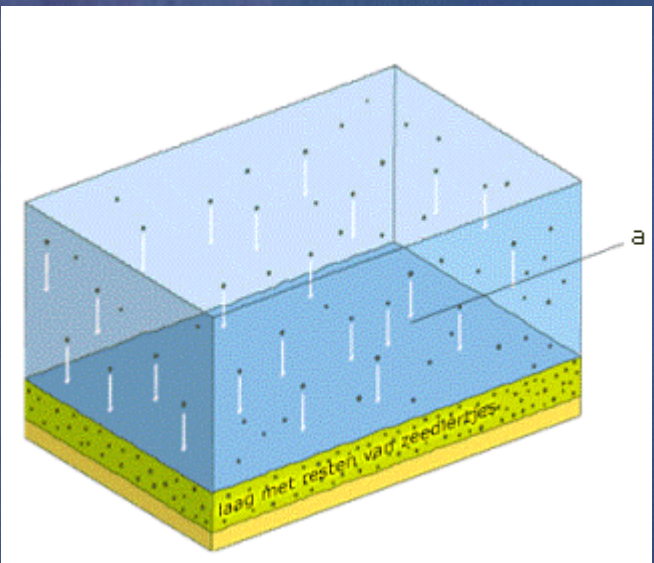
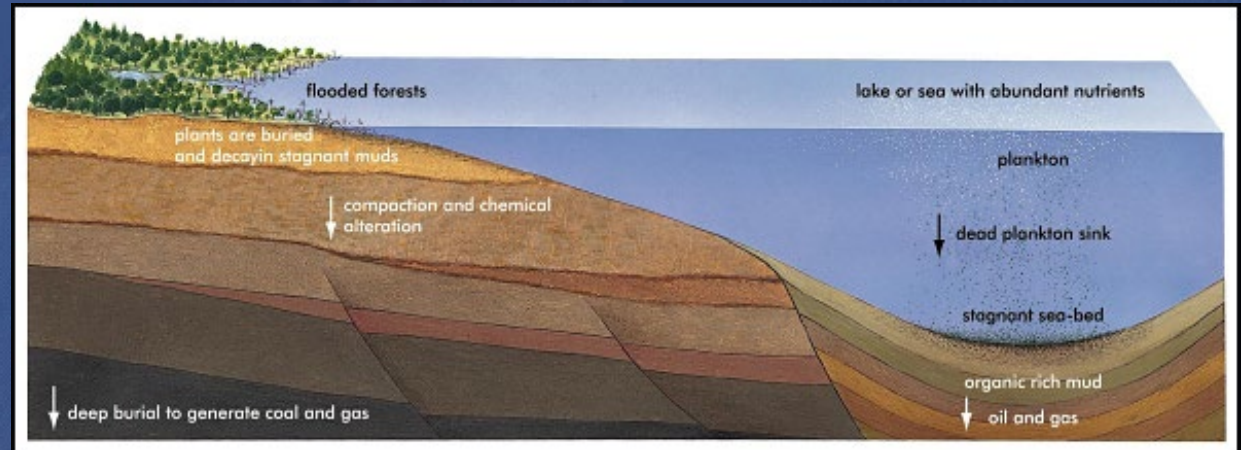


Figure 5-1

Marine and lacustrine benthic environments. Oxygen contents in ml/l H₂O are 0.1 in I, suboxic 1 to 0.1, and anoxic less than 0.1 OM. Types I to IV are defined in Table 6.



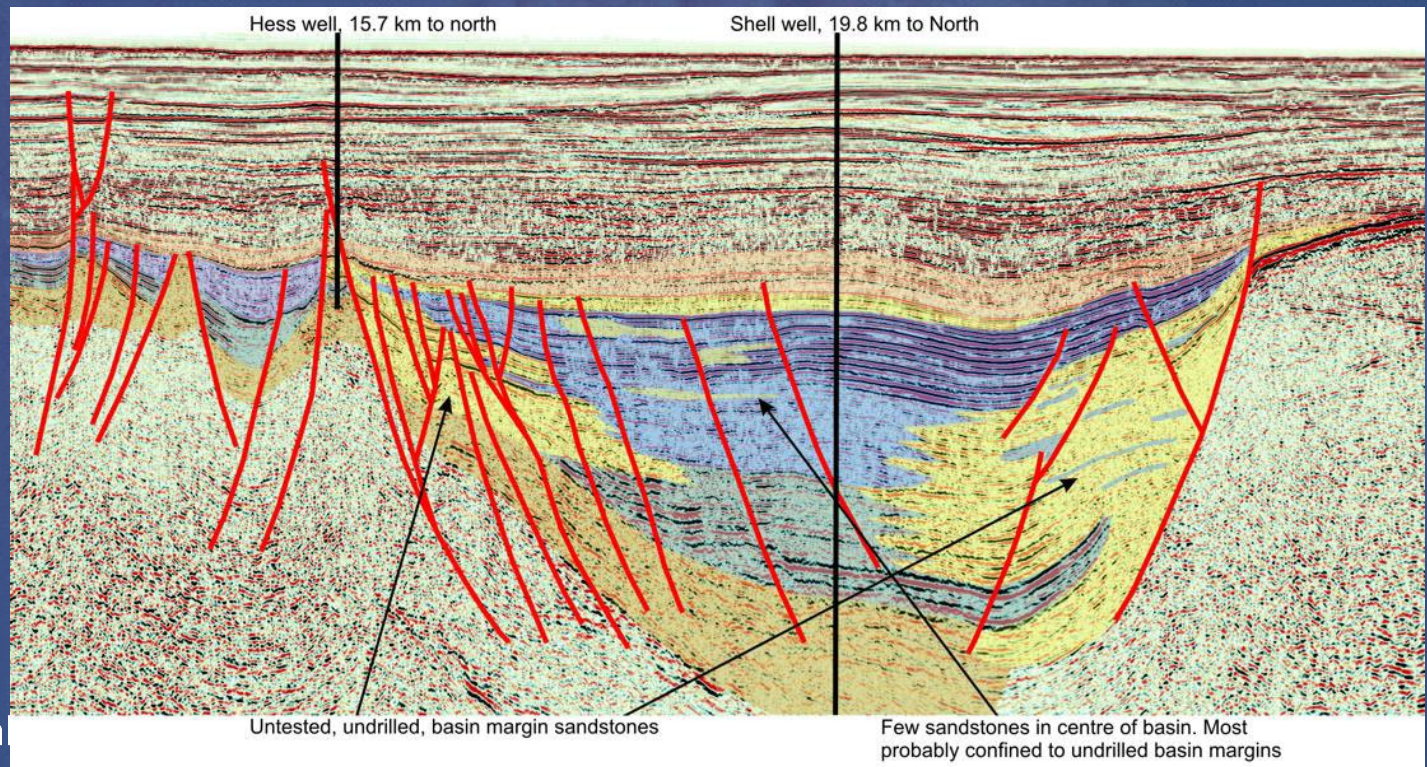
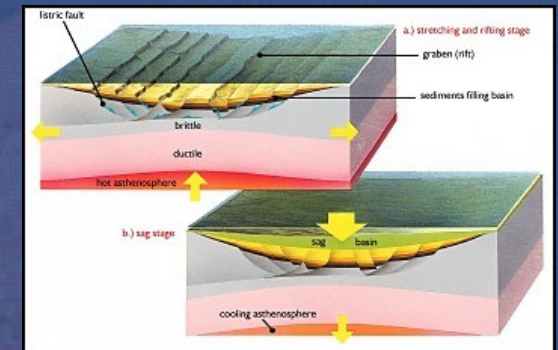
Plantenresten



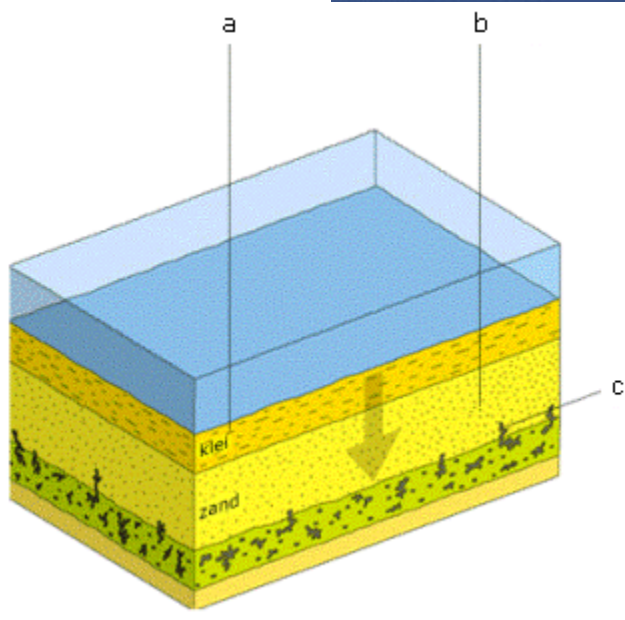
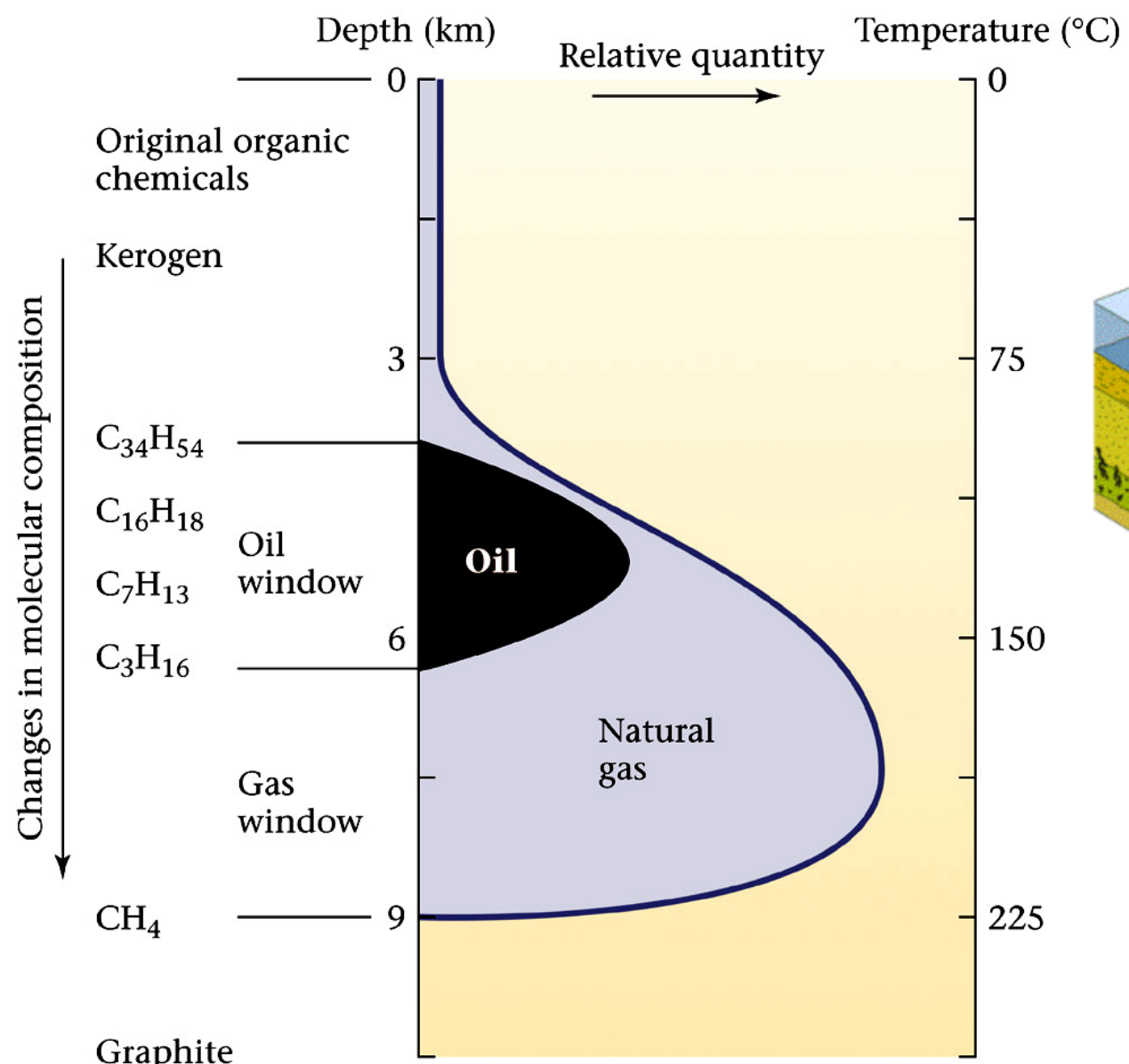
Voldoende ophoping

Plaattektoniek: dalend!

1. Actieve rift
2. Post-rift daling door gewicht sediment



Genoeg druk en temperatuur!

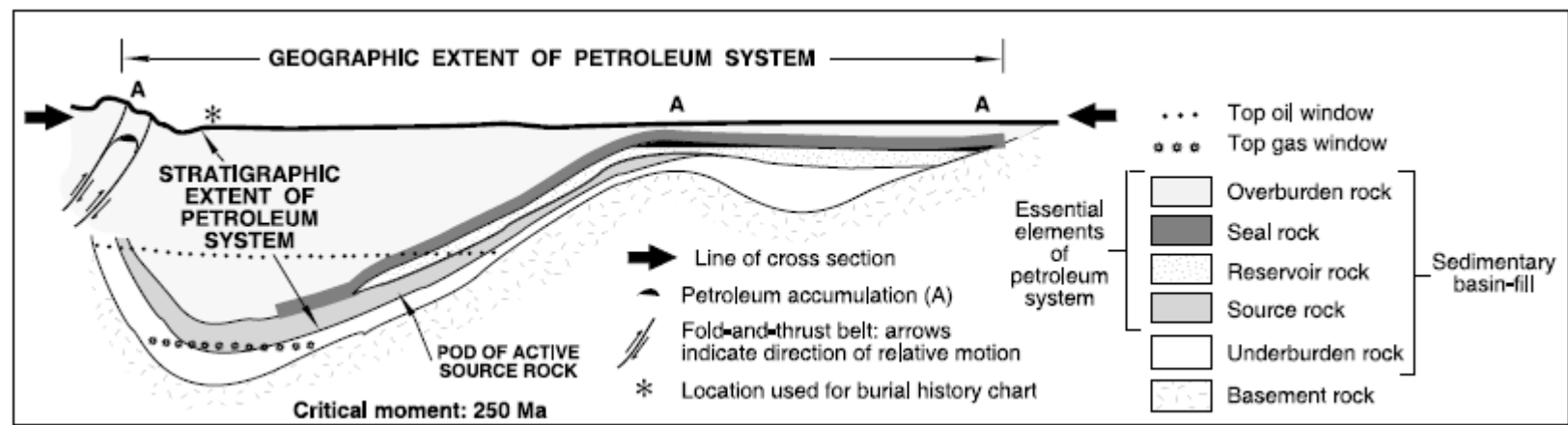
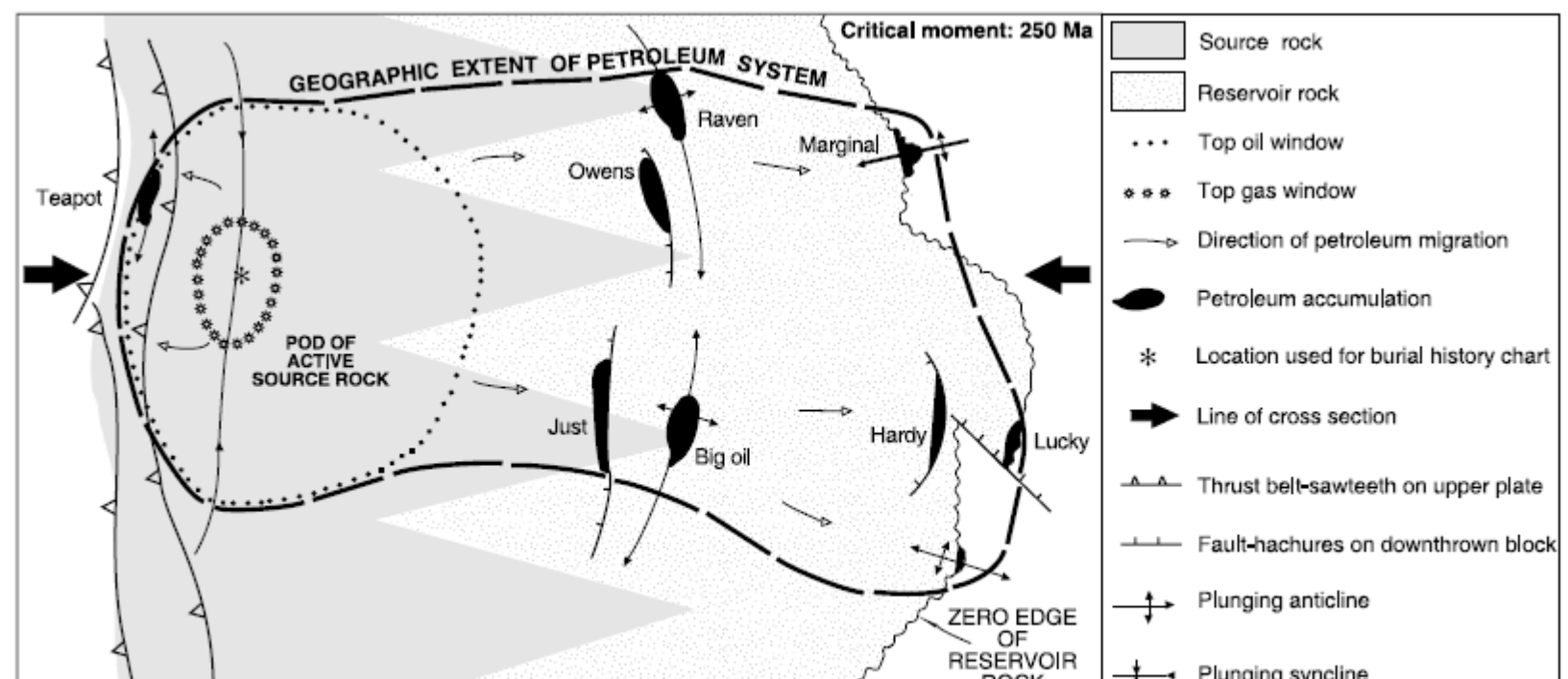


Migratie

Drijvende krachten achter migratie:

- Drijfvermogen
olie en gas drijven op water, verschil
voor gas groter dan voor olie
- Hydrodynamische stroming
kan de richting van migratie
beïnvloeden, vaak klein effect buiten
zones met hoge druk

Niet op oorspronkelijke plek



Petroleum system

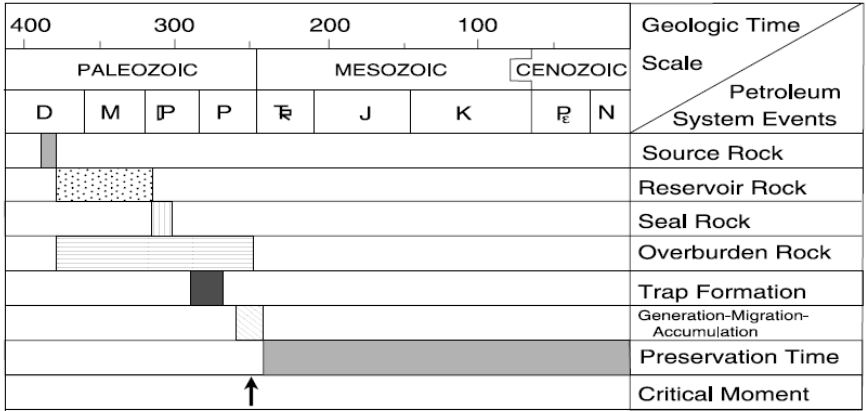
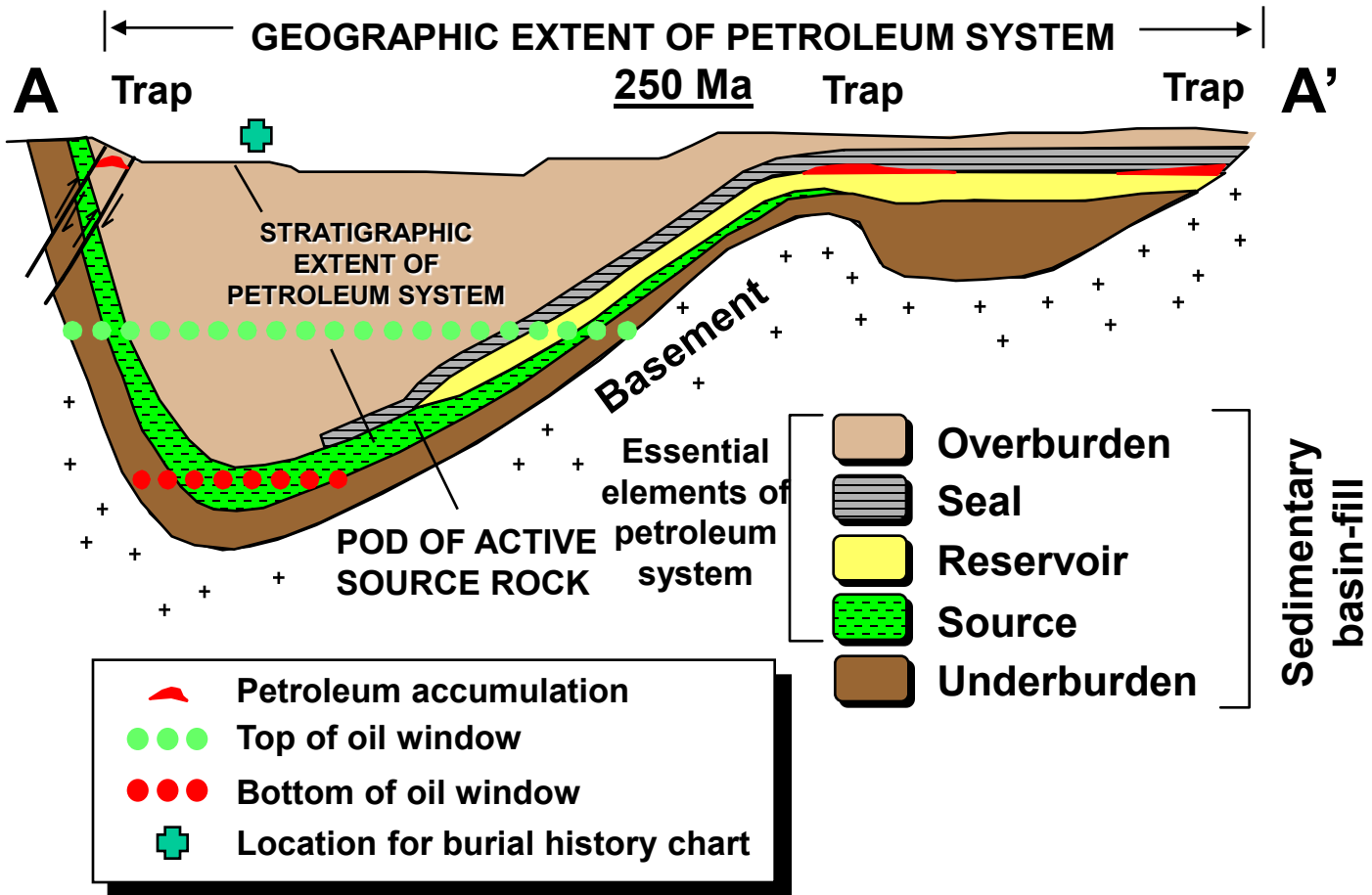


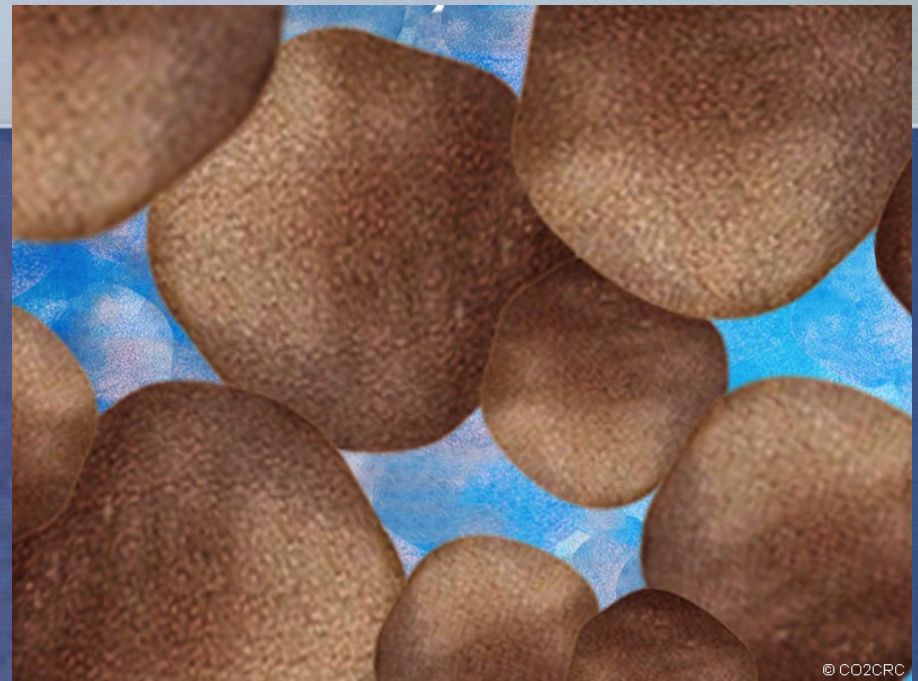
Figure 3-6. From Magoon and Dow, 1994; courtesy AAPG.



Hoeveel ruimte?

Porositeit (hoeveelheid
gas of olie)

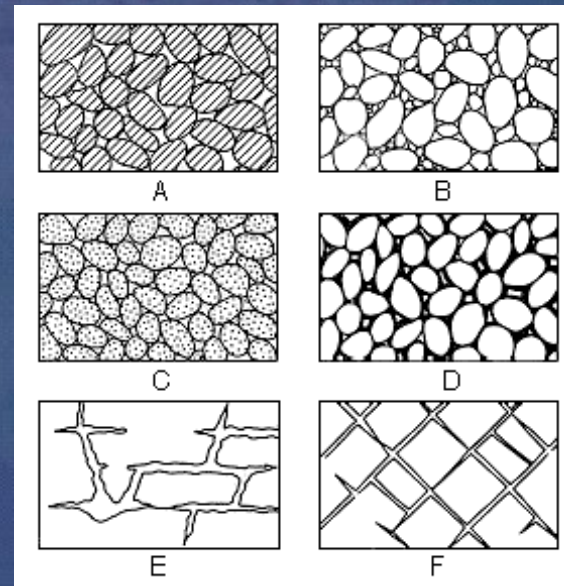
Permeabiliteit (snelheid
migratie)



© CO2CRC



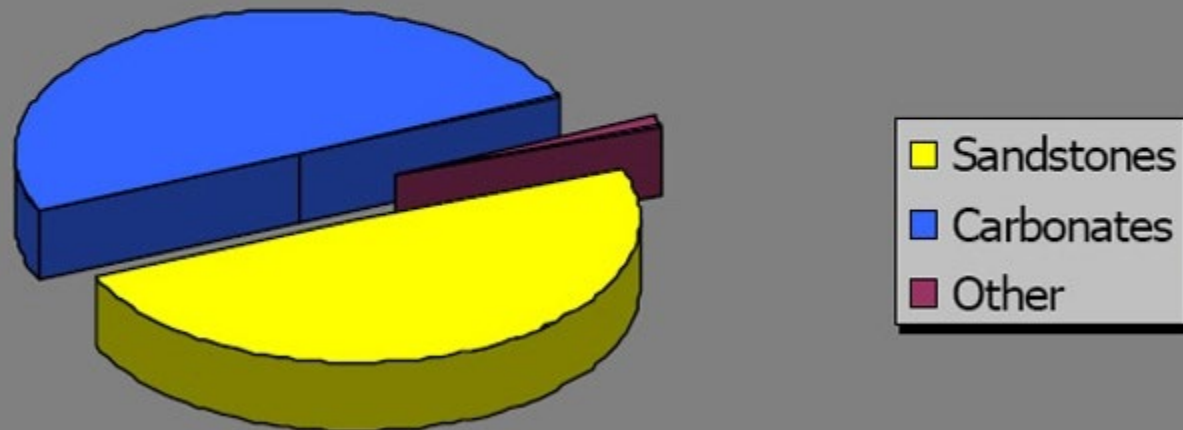
© CO2CRC



Welke gesteenten?

Reservoir gesteente

**Percentage of World Oil & Gas
Reserves by Reservoir Rock Type**



Opvang

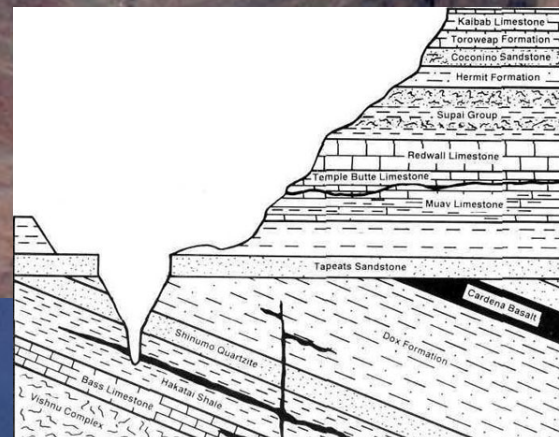
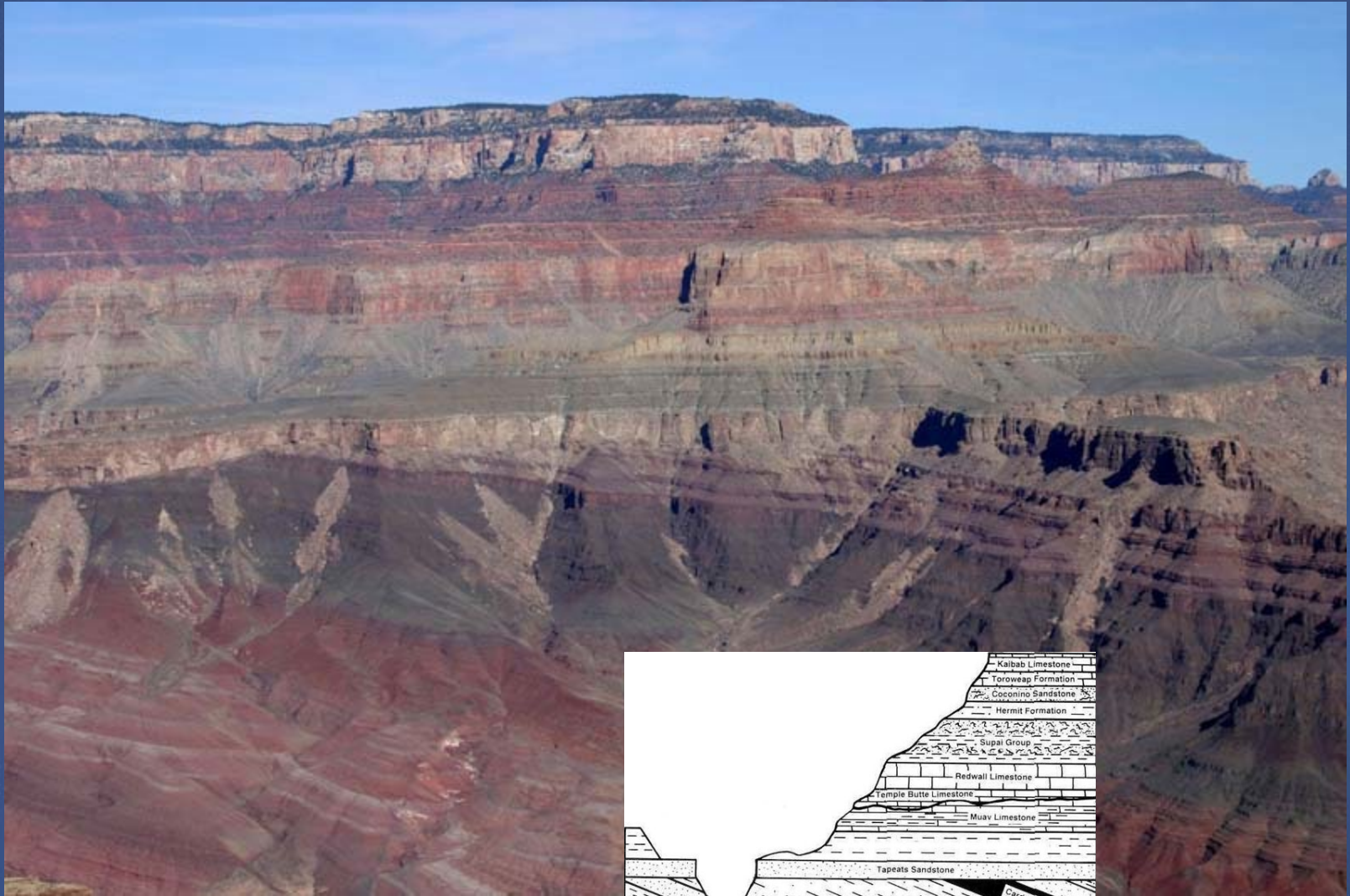
Traps

Poreus gesteente bedekt door niet-doorlatend gesteente (seal)

–Sedimentair: uitwiggen of onconformiteit (tektoniek!)

–Structureel (tektoniek!!!): plooï of breuk

Discordantie



Locale vorm

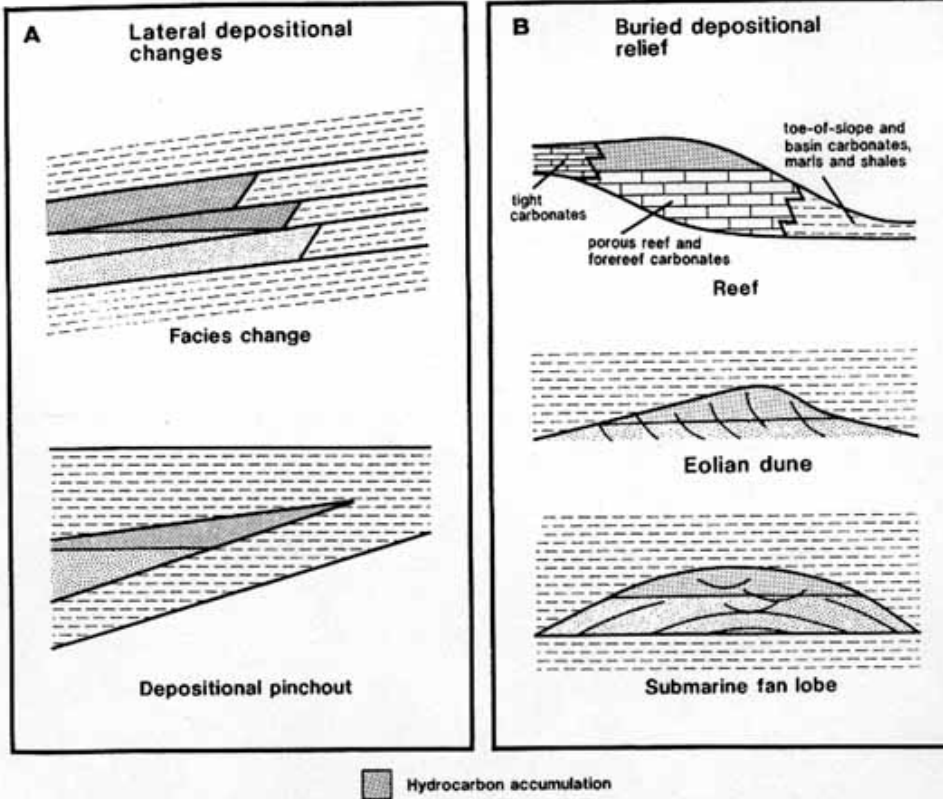
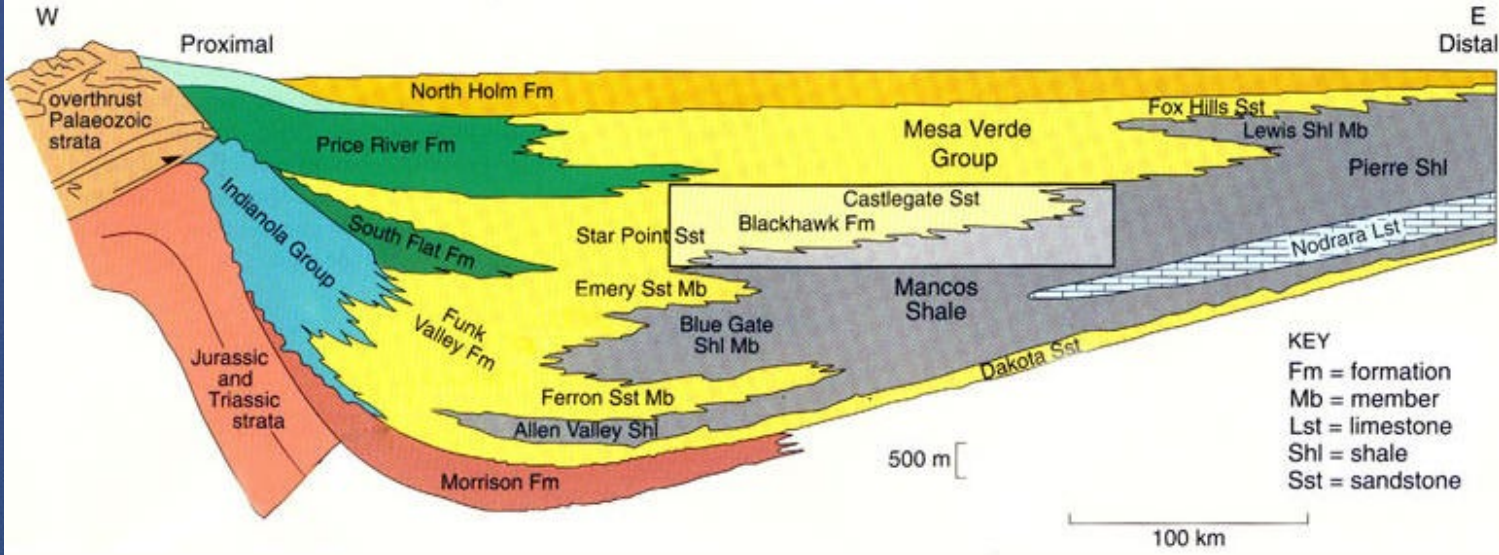
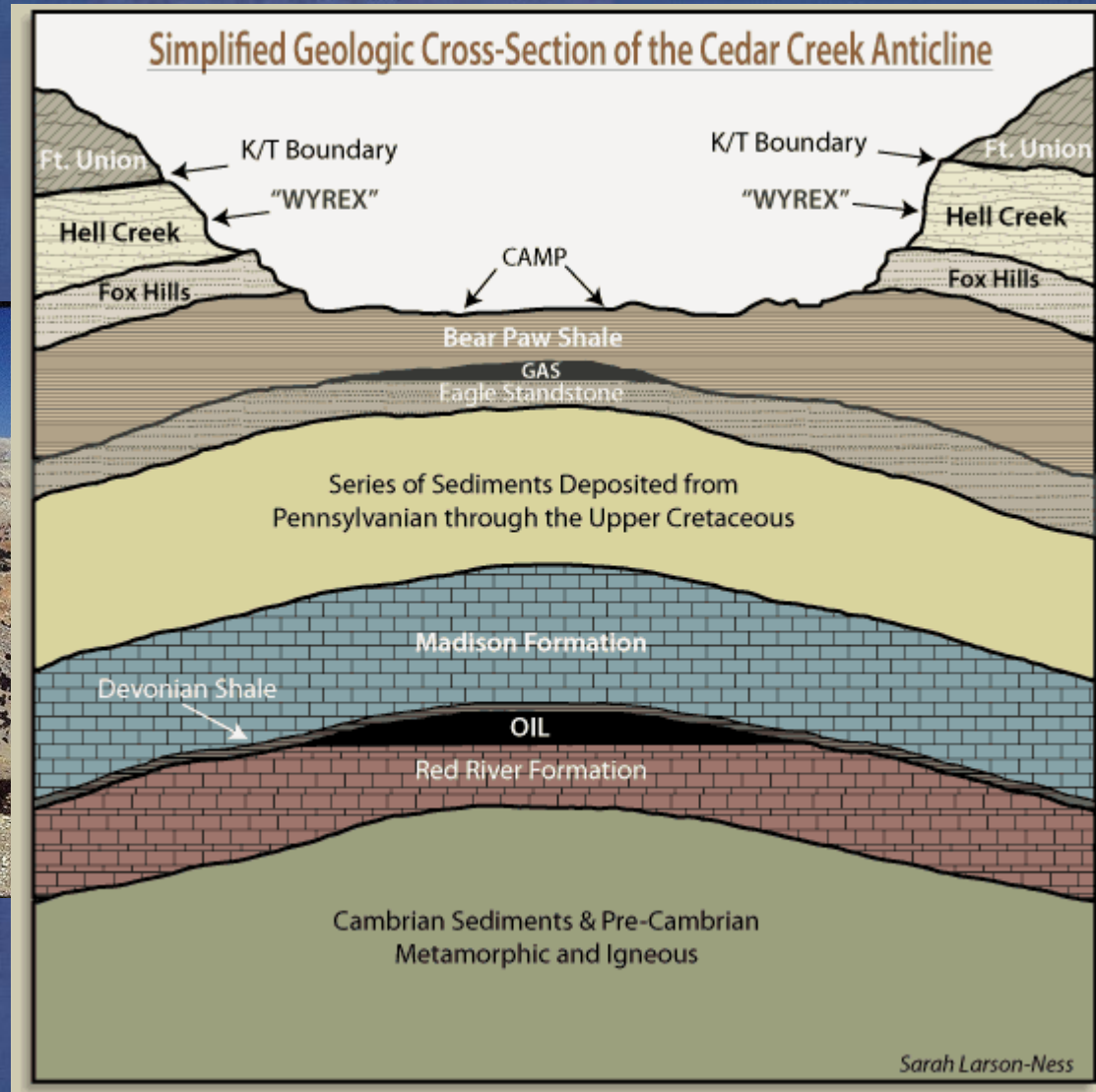


Figure 13.7. Primary or depositional stratigraphic traps. (A) Traps created by lateral changes in sedimentary rock type during deposition. Bottom; reservoir termination due to facies change. In each case, the trap is created by burial by younger impermeable section to the west.

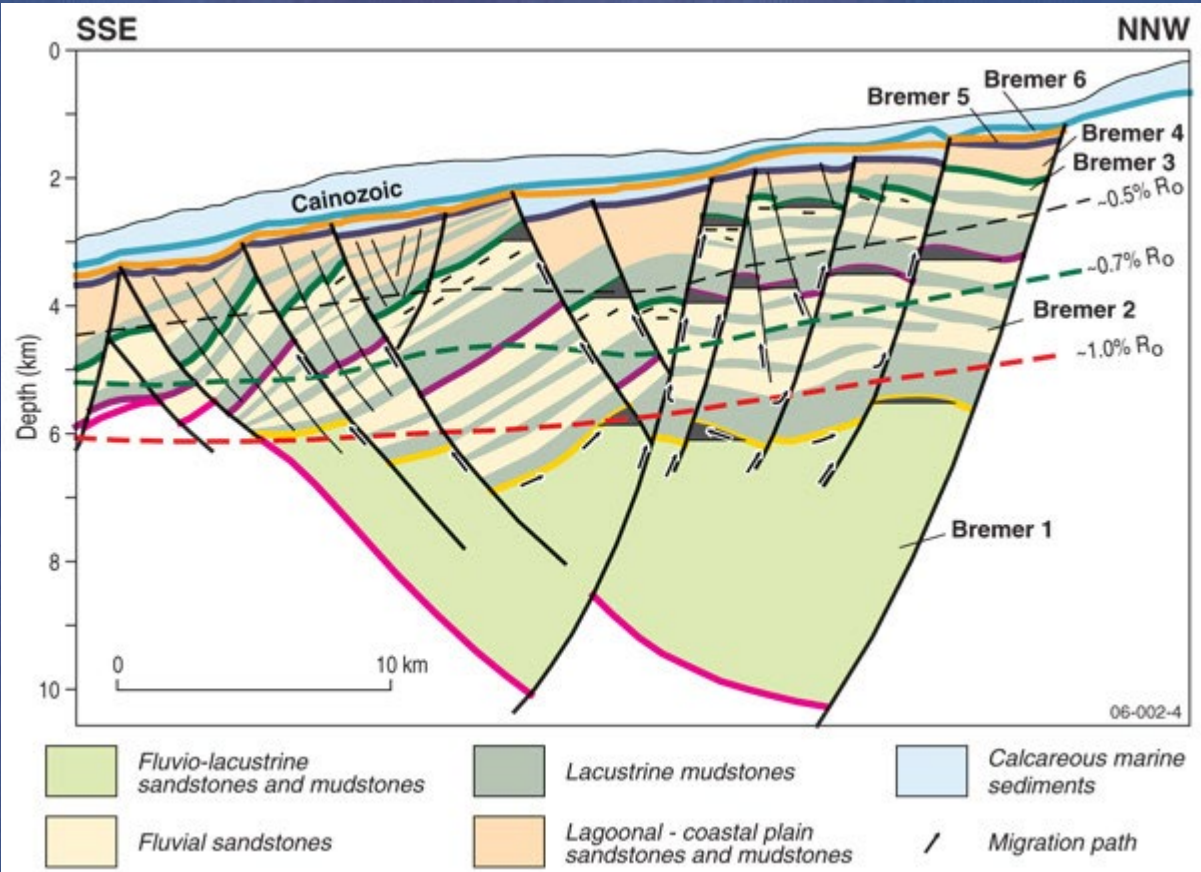
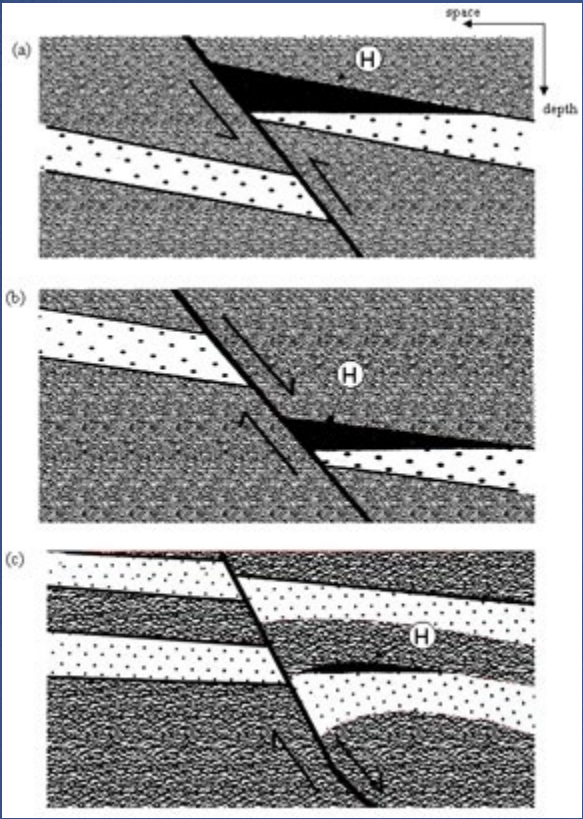


Plooiing

Anticline



Breuken



Afsluiting

Liefst elastisch of plastisch: geen breuken,
geen verlies



Analoog

Zwaartekracht bij regen



Andersom!

Bouyancy (drijfvermogen) bij olie en gas

Afsluiting

Productieboring

Reservoir

Secundaire migratie

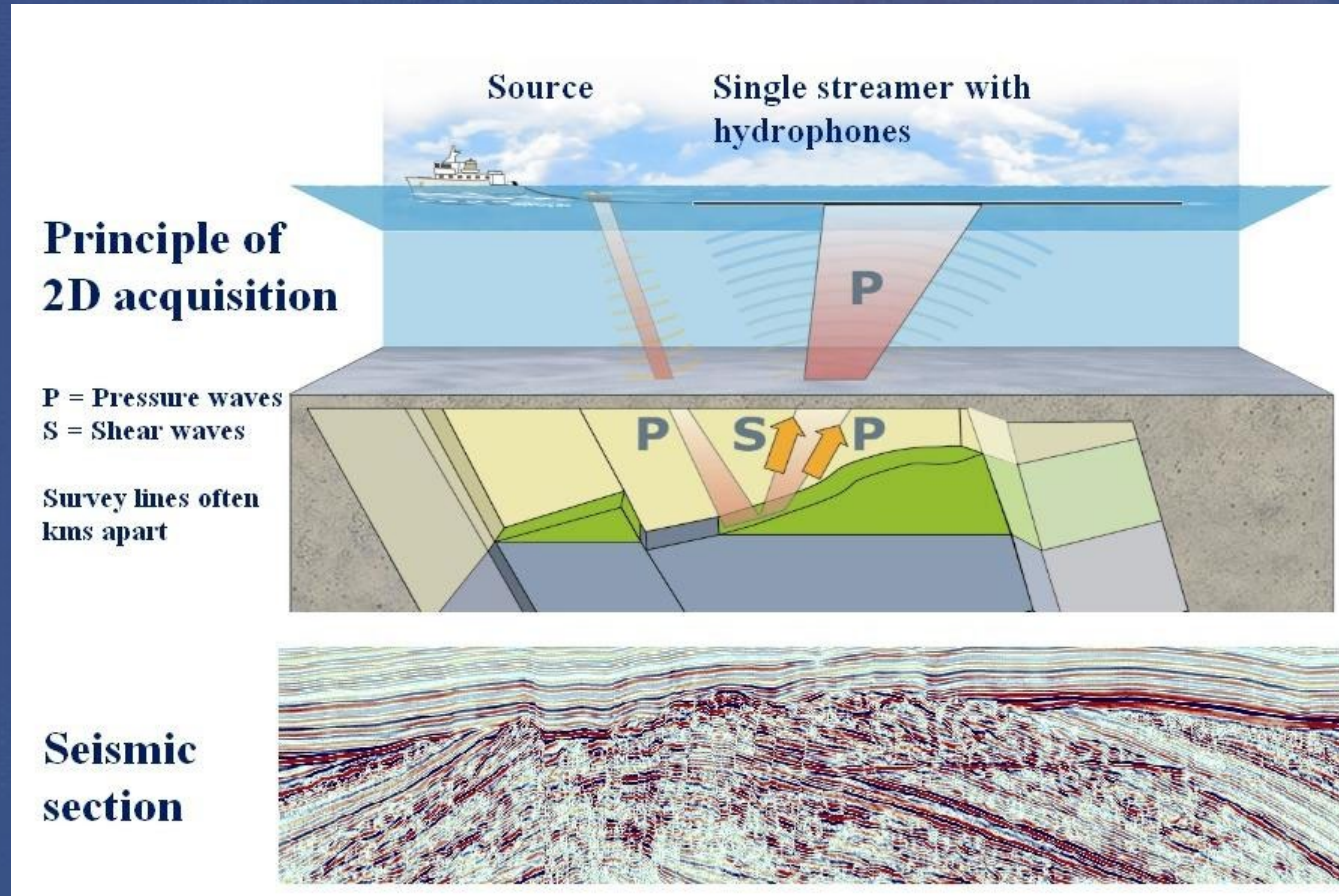
Migratie

Olie en gas ontwikkeling

Moedergesteente

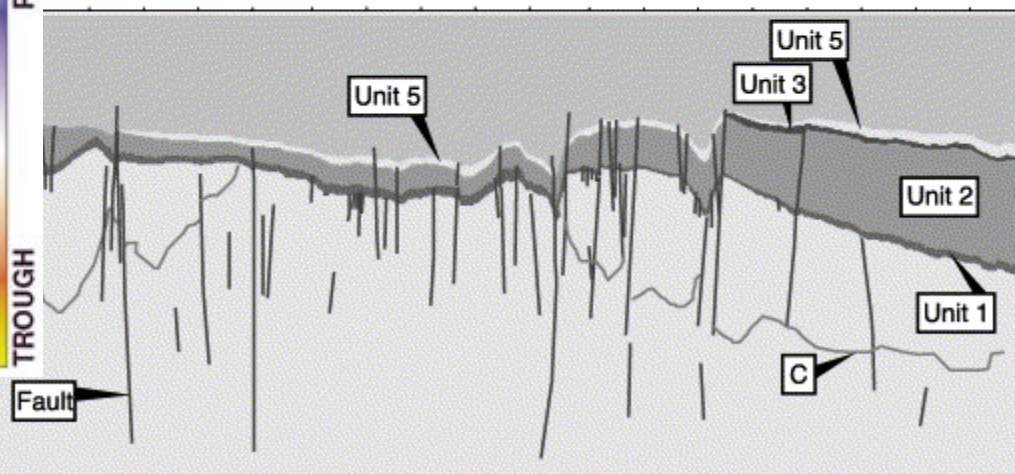
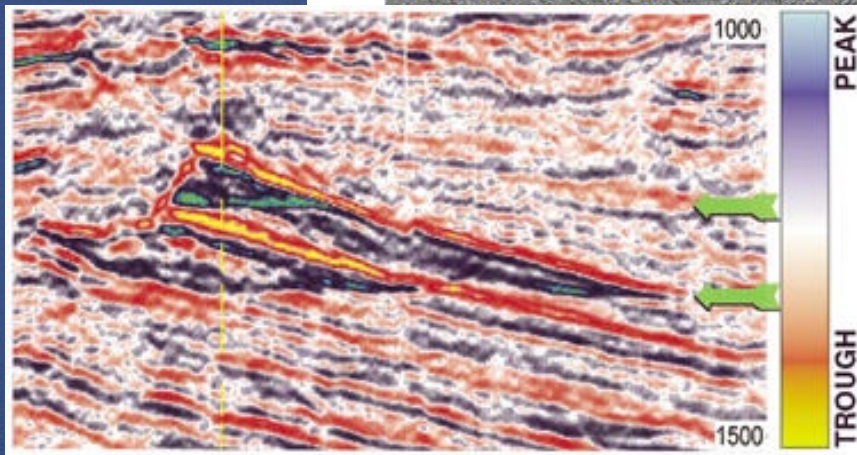
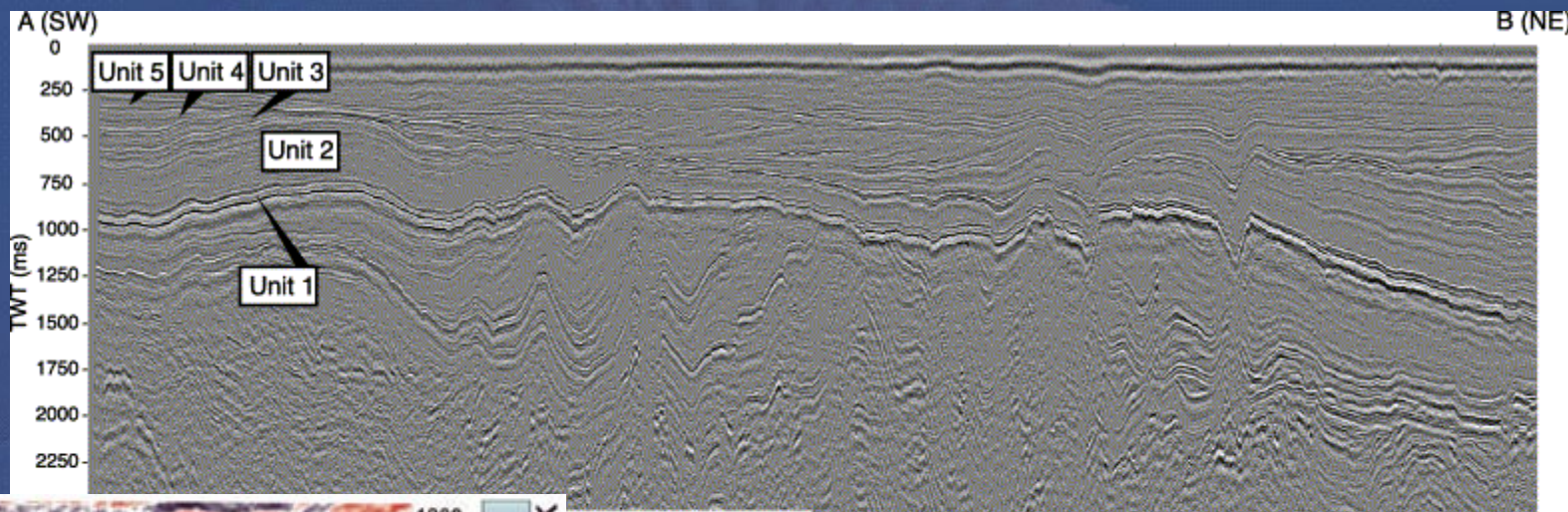
Draai het om!

Randvoorwaarden duidelijk: op zoek!



Lijntjes staren

Verbind reflectoren en interpreteer

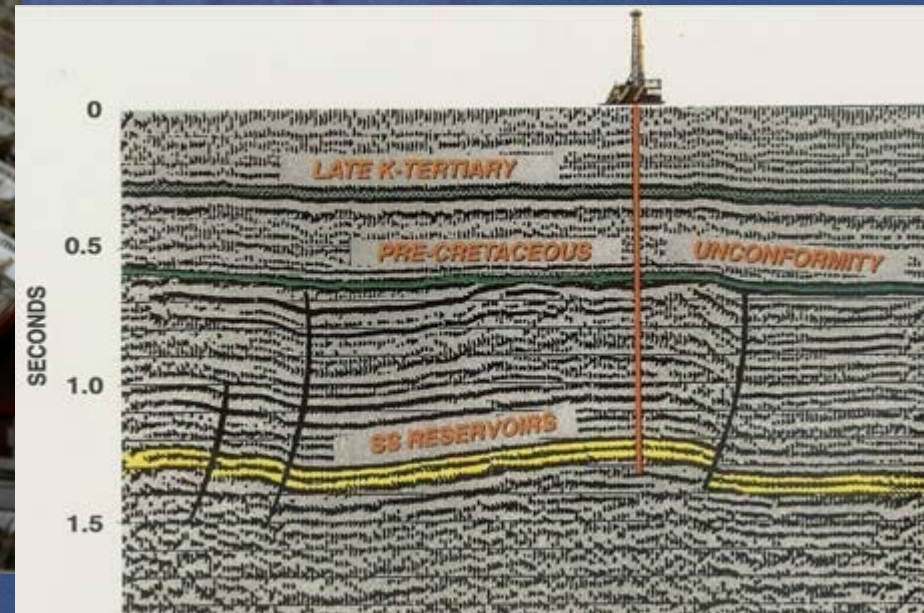


Boring

Welke reflectie is wat?

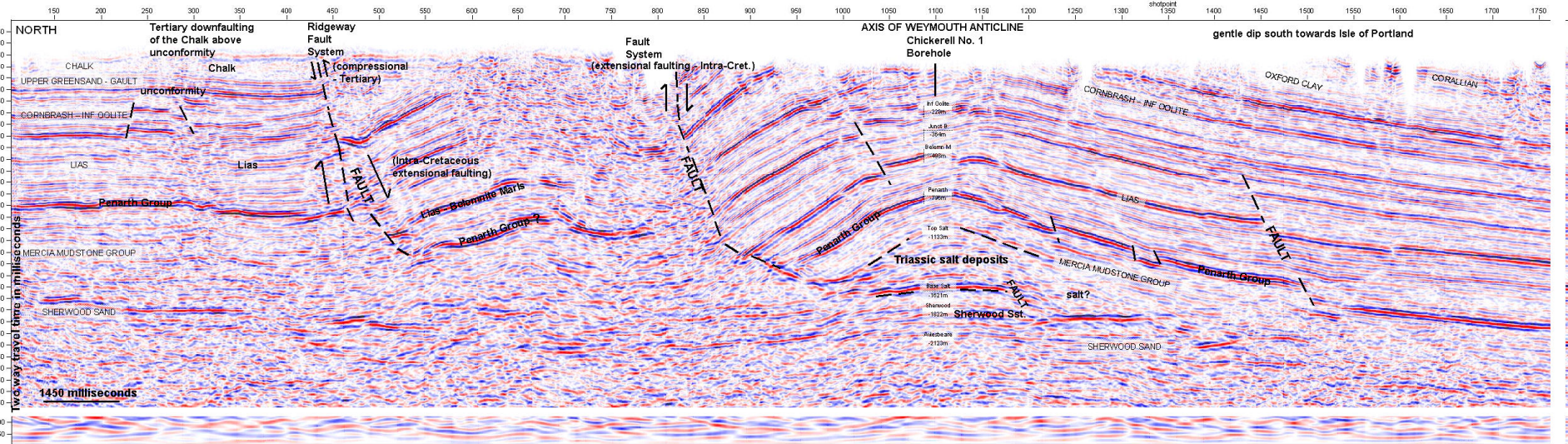
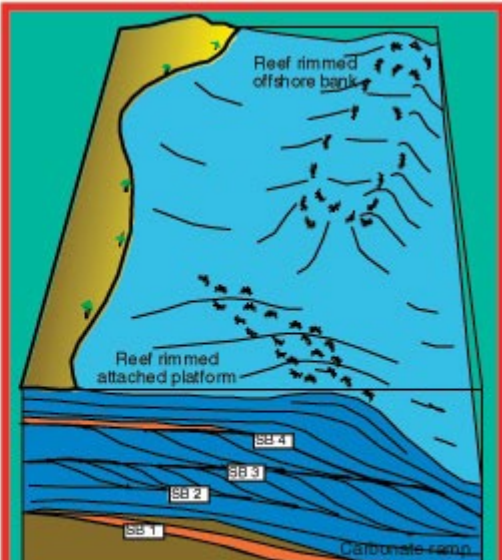
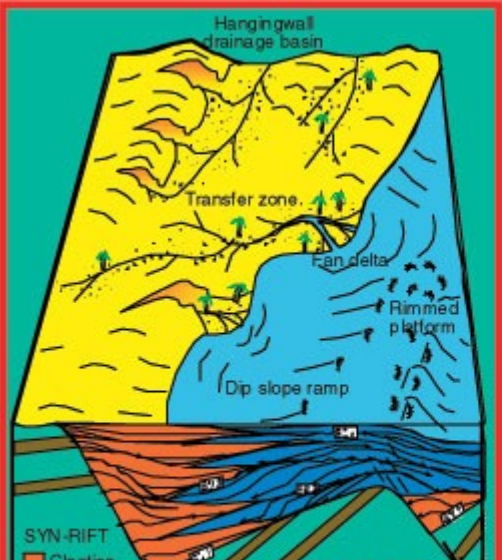


Courtesy of Chevron-Teneco Corp.



Interpreten

Facies models



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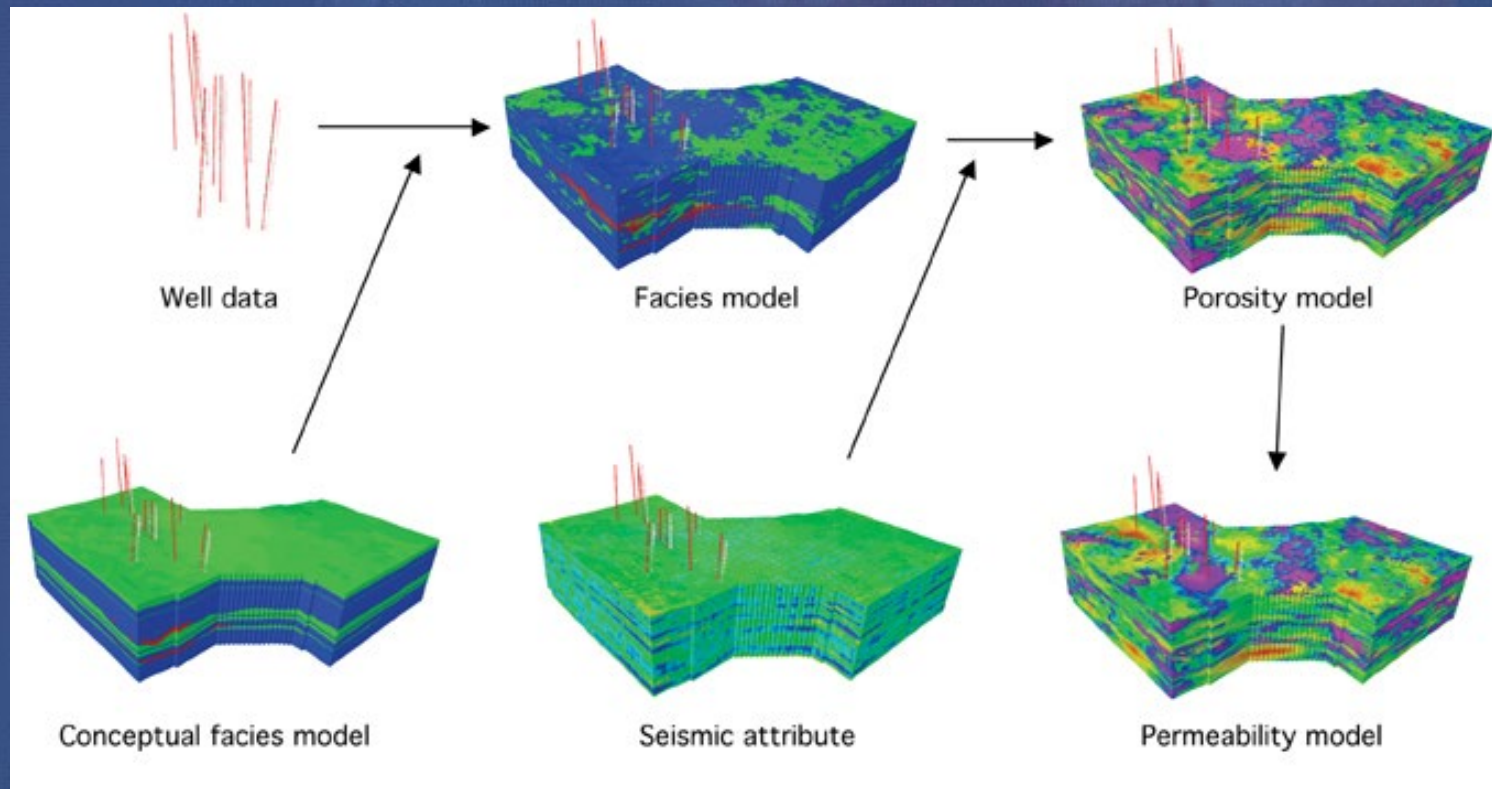
Part of the original images has been cut away to reduce the size and some labelling has been added. Go to the website of UK Onshore
Geological Library - Google "ukogl", or type in - "www.ukogl.org.uk" for full version and more information. See original for serious work.
(this version has been modified by Ian West, 2010 - interpretation of faults etc. shown here is provisional and not accurate)

5 kilometres

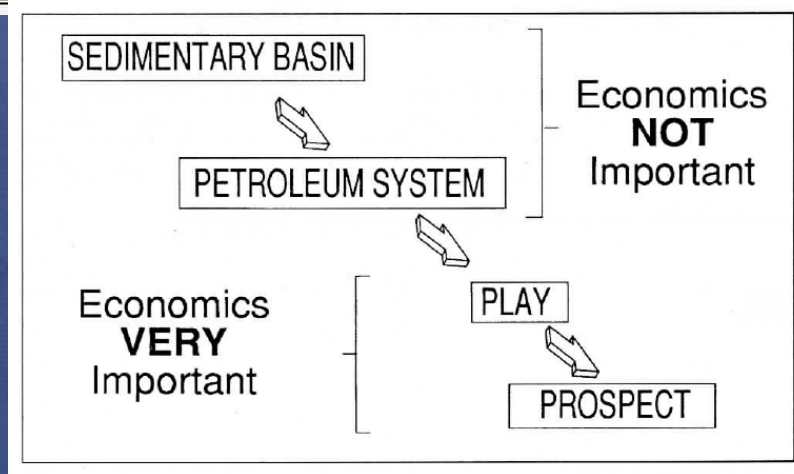
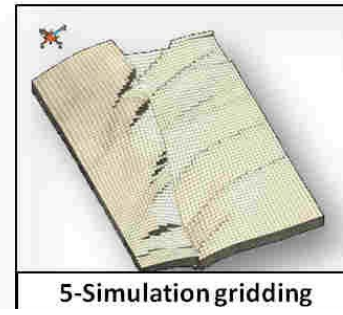
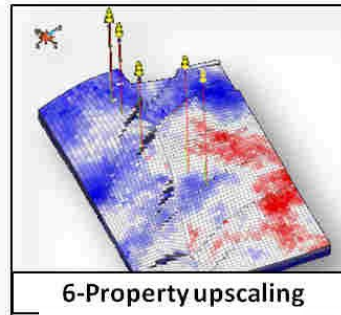
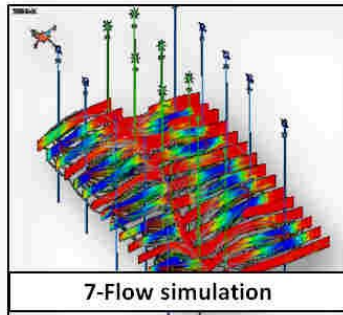
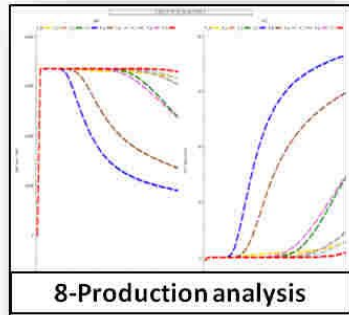
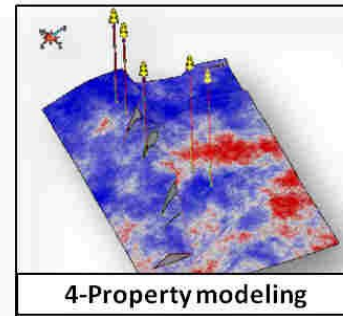
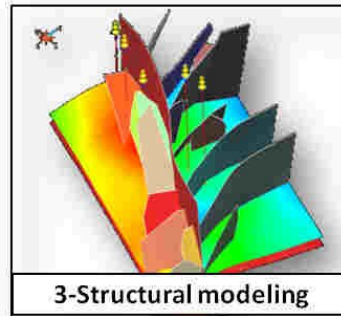
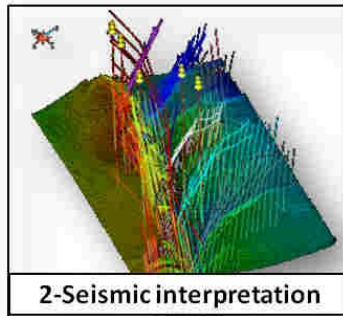
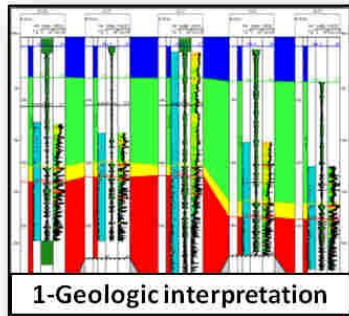
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present

Naar 3D!

Voorspellende modellen op basis van genoemde parameters: reservoir modelling



Rendabel?



Toepassingen

Regionale voorbeelden

1. Nederland
2. Midden-Oosten

Hoe is uit basisprincipes het voorkomen van gas en olie in deze gebieden te plaatsen?

Regionale voorbeelden

1. Nederland

Vooral gas, een beetje olie!

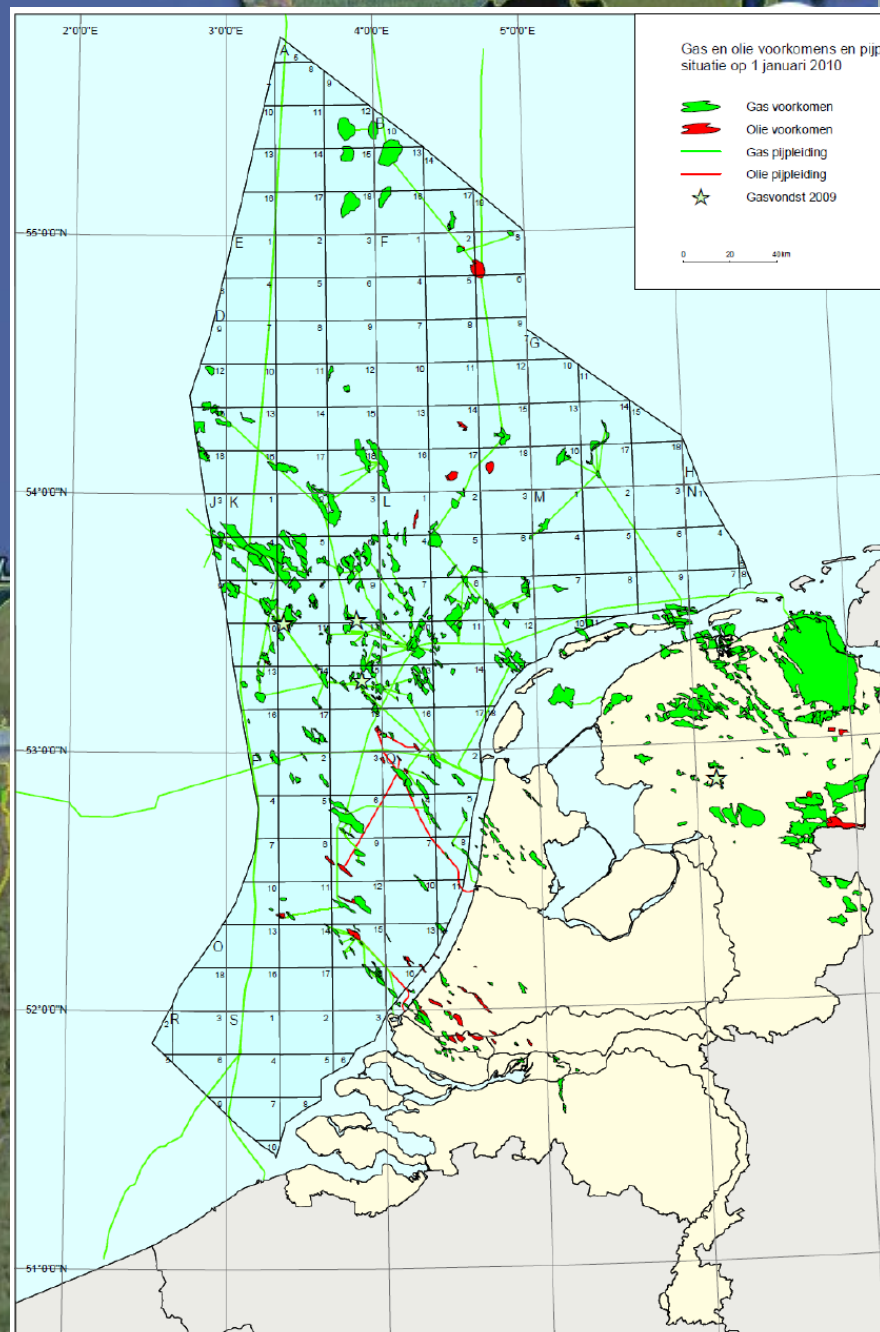
Cleaver Bank

Norderney
Juist

Brown Ridge

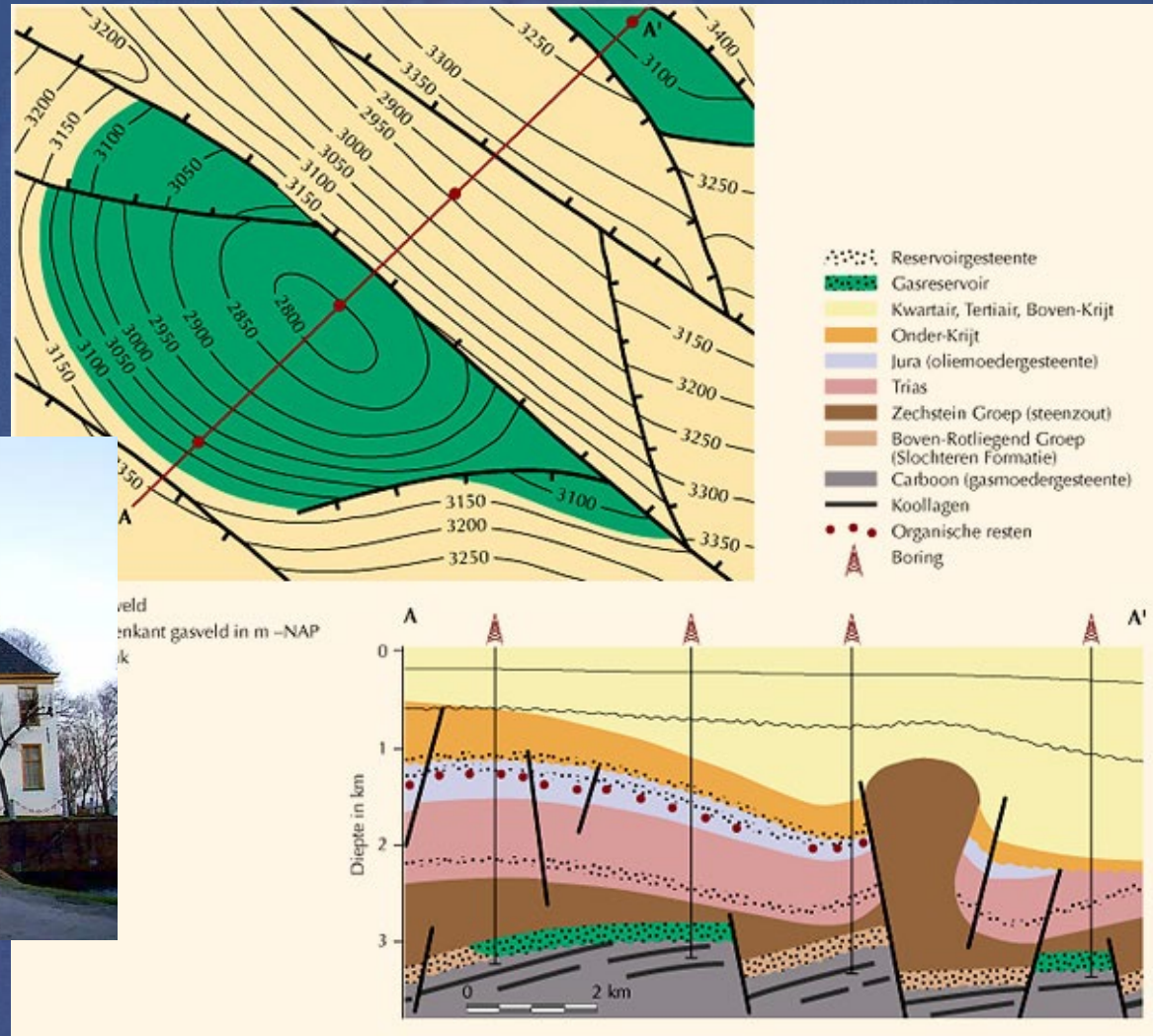
★ Amsterdam

Netherlands

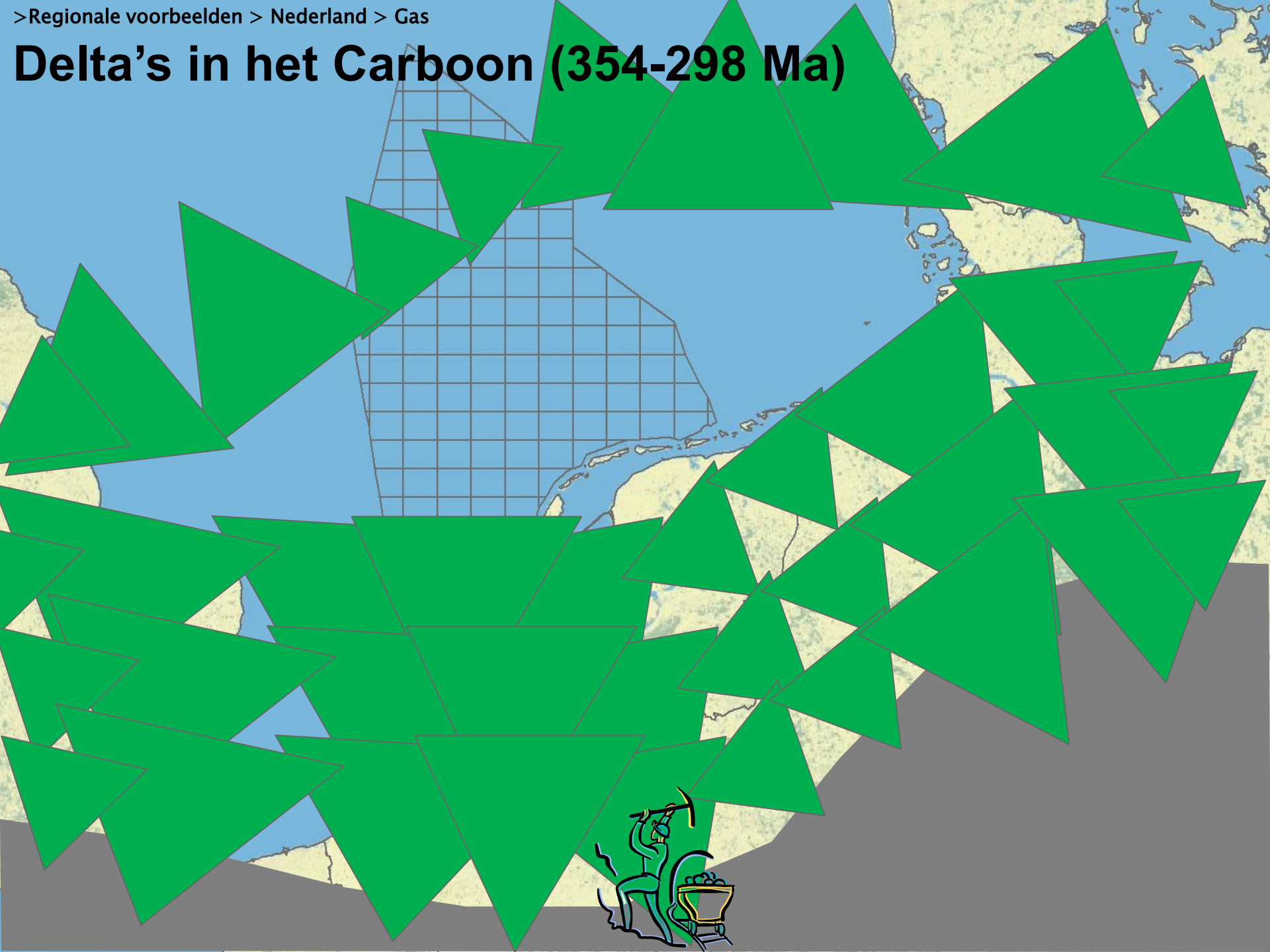


Slochteren!

1. Gas Hoe is dat daar gekomen?



Delta's in het Carboon (354-298 Ma)

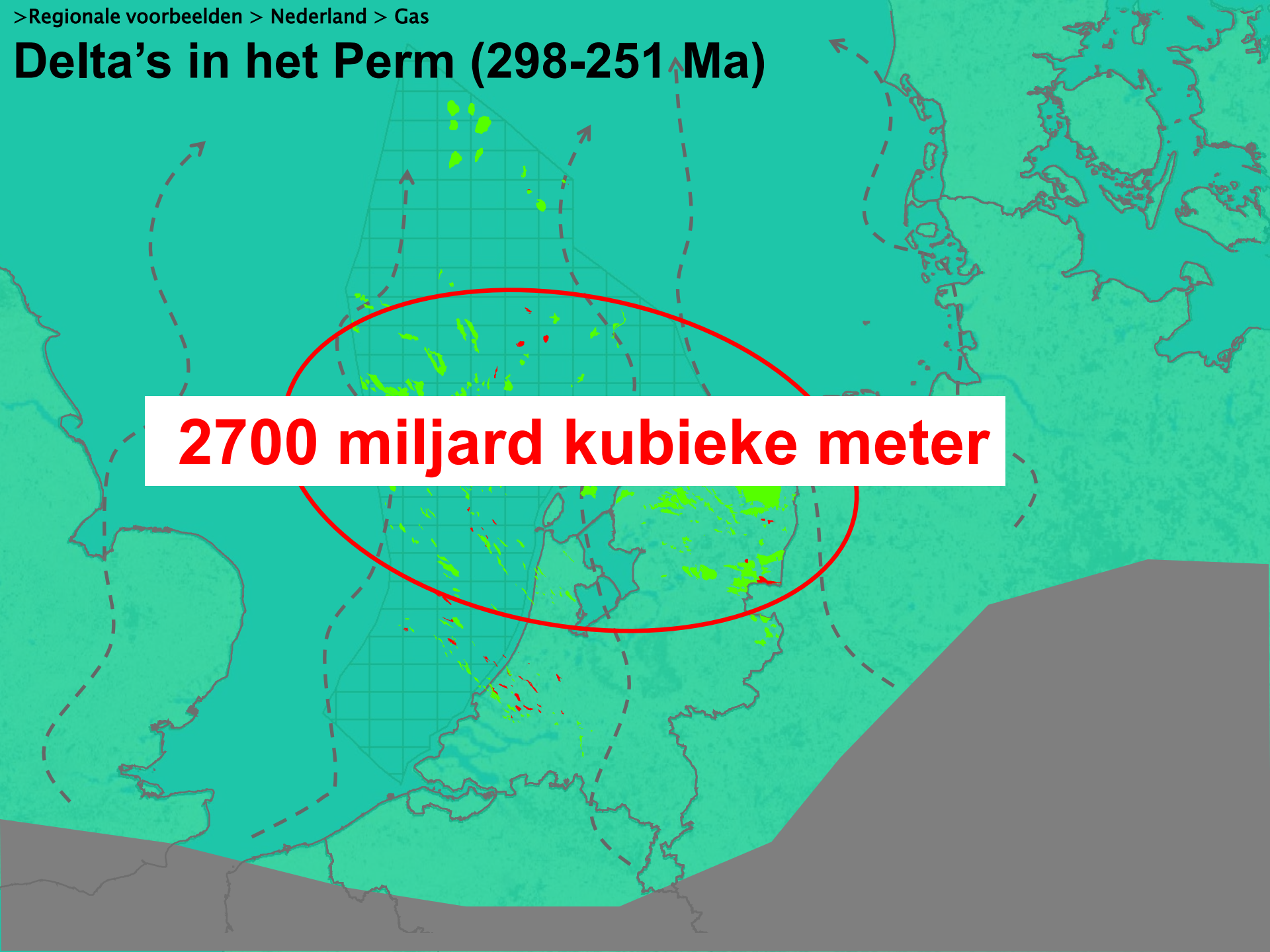


Moedergesteente

Amsterdam

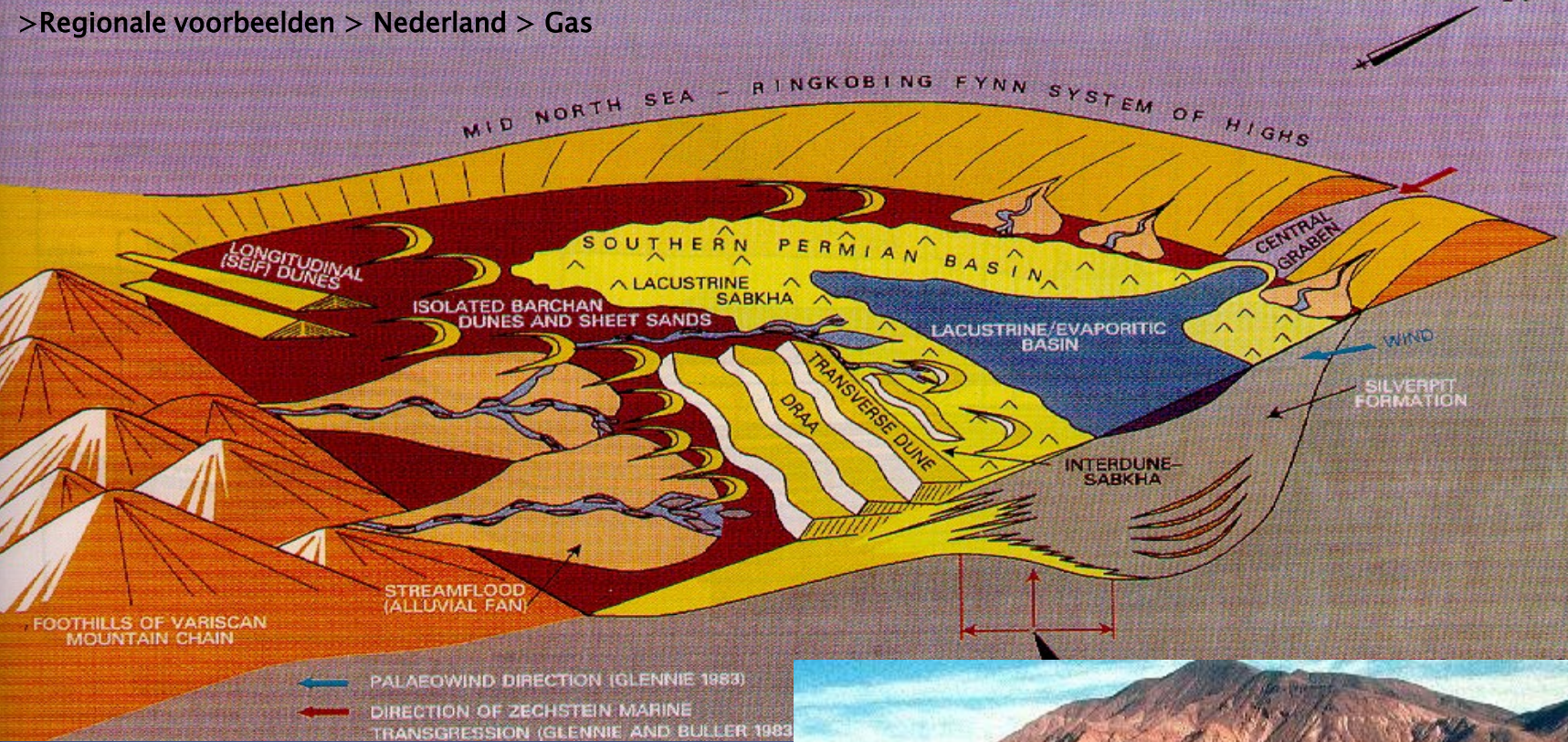


Delta's in het Perm (298-251 Ma)



The background is a map of the North Sea region during the Permian period. A red oval highlights a large area in the central North Sea, indicating the extent of a delta system. Within this oval, a grid of dashed lines is visible, and several yellow and red spots are scattered, likely representing gas fields or specific geological features. The surrounding landmasses are shown in light green, and the sea is in light blue. Dashed lines with arrows indicate the direction of sediment transport or current flow.

2700 miljard kubieke meter



Reservoirsteente



Eindhoven

Varistisch gebergte (Ardennen!!)

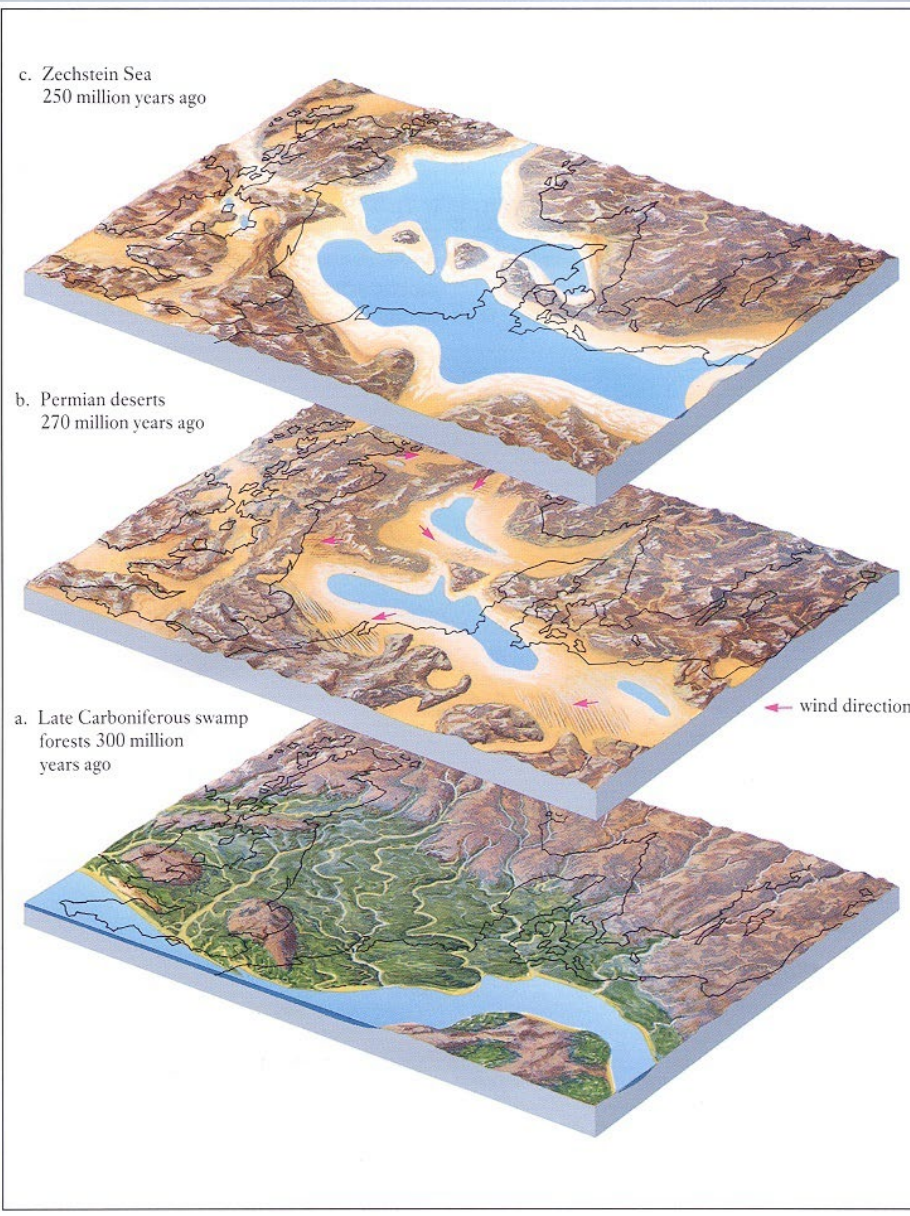


‘Kootwijkerzand’



Afsluiting

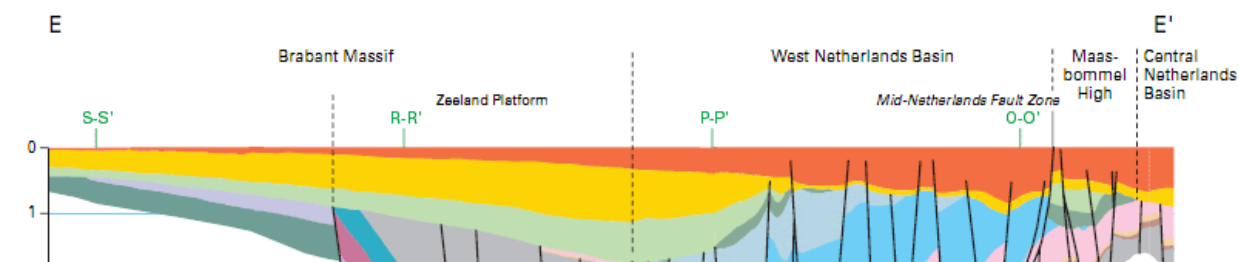
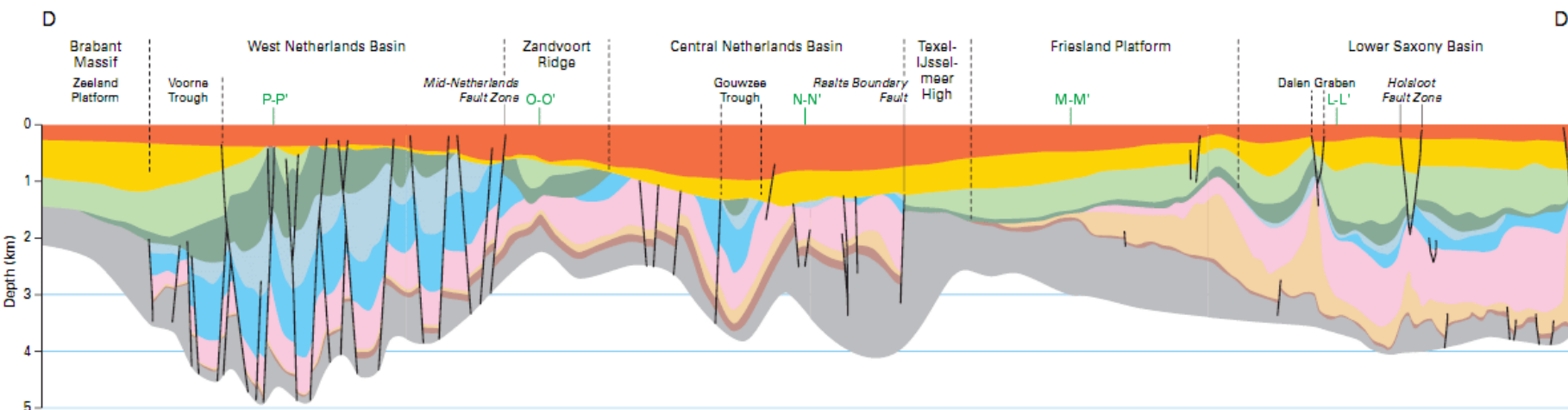
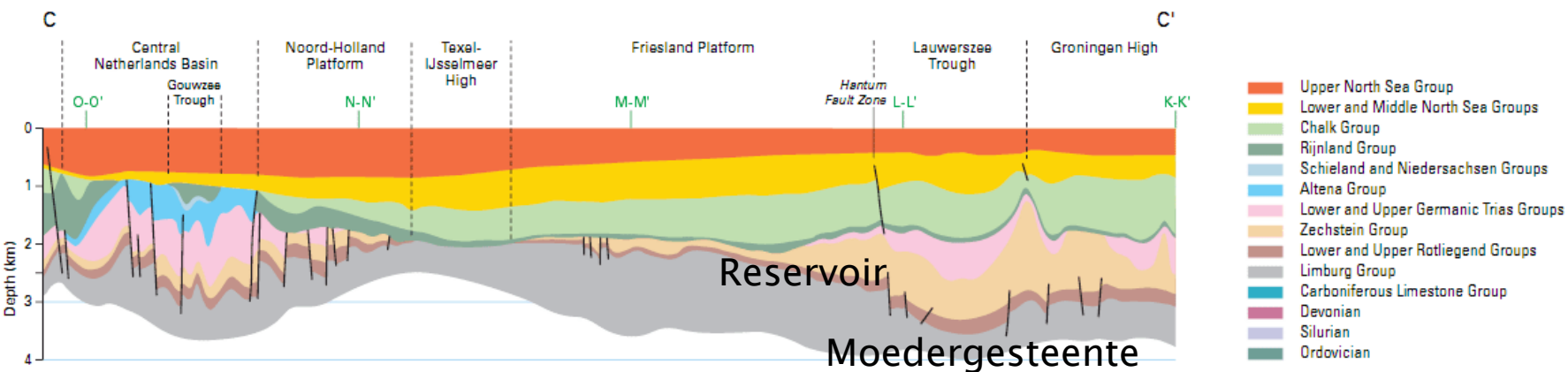
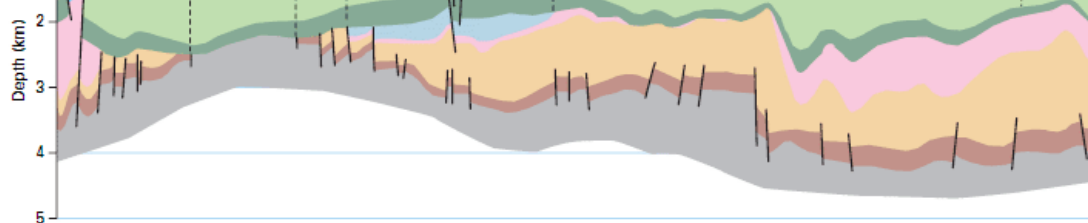
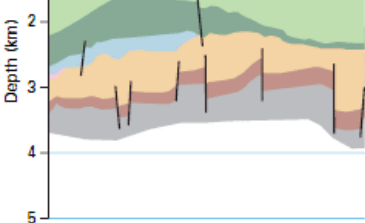
Texel



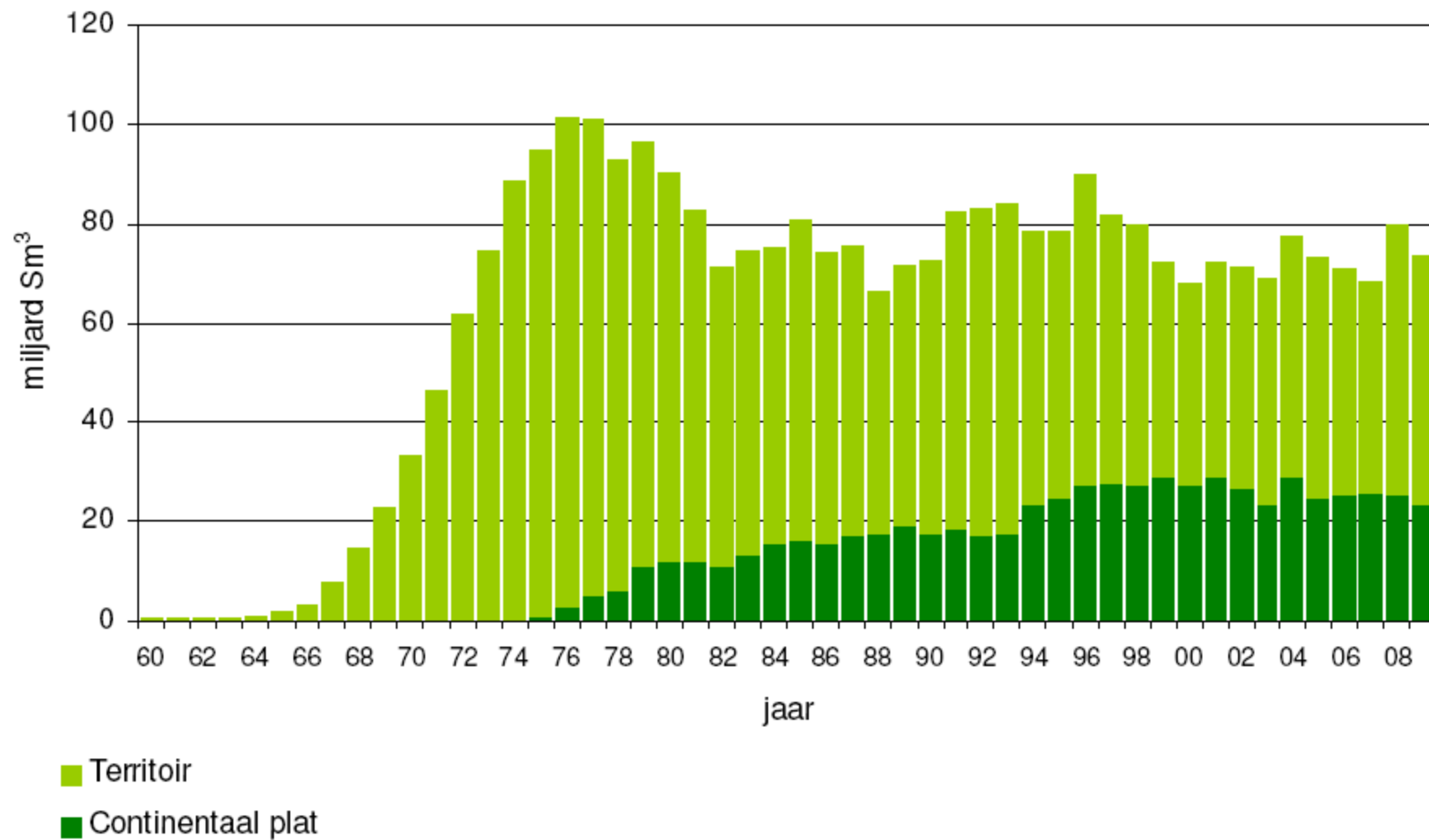
**3. Perm, Zechstein:
zoutwoestijn: afdekkende
laag**

**2. Perm, Rotliegendes:
Rode duinzanden in
woestijn:
reservoirgesteente**

**1. Carboon:
steenkuol, tropische
delta: brongesteente
aardgas**



Aardgasproductie





Producers	mcm	% of world total
Russia	650 993	21.5
United States	546 140	18.0
Canada	183 395	6.0
Islamic Rep. of Iran	106 693	3.5
Norway	90 839	3.0
Algeria	89 970	3.0
Netherlands	76 334	2.5
United Kingdom	76 004	2.5
Indonesia	69 691	2.3
Peoples Rep. of China	67 746	2.2
Rest of the world	1 073 596	35.5
World	3 031 401	100.0

2007 data

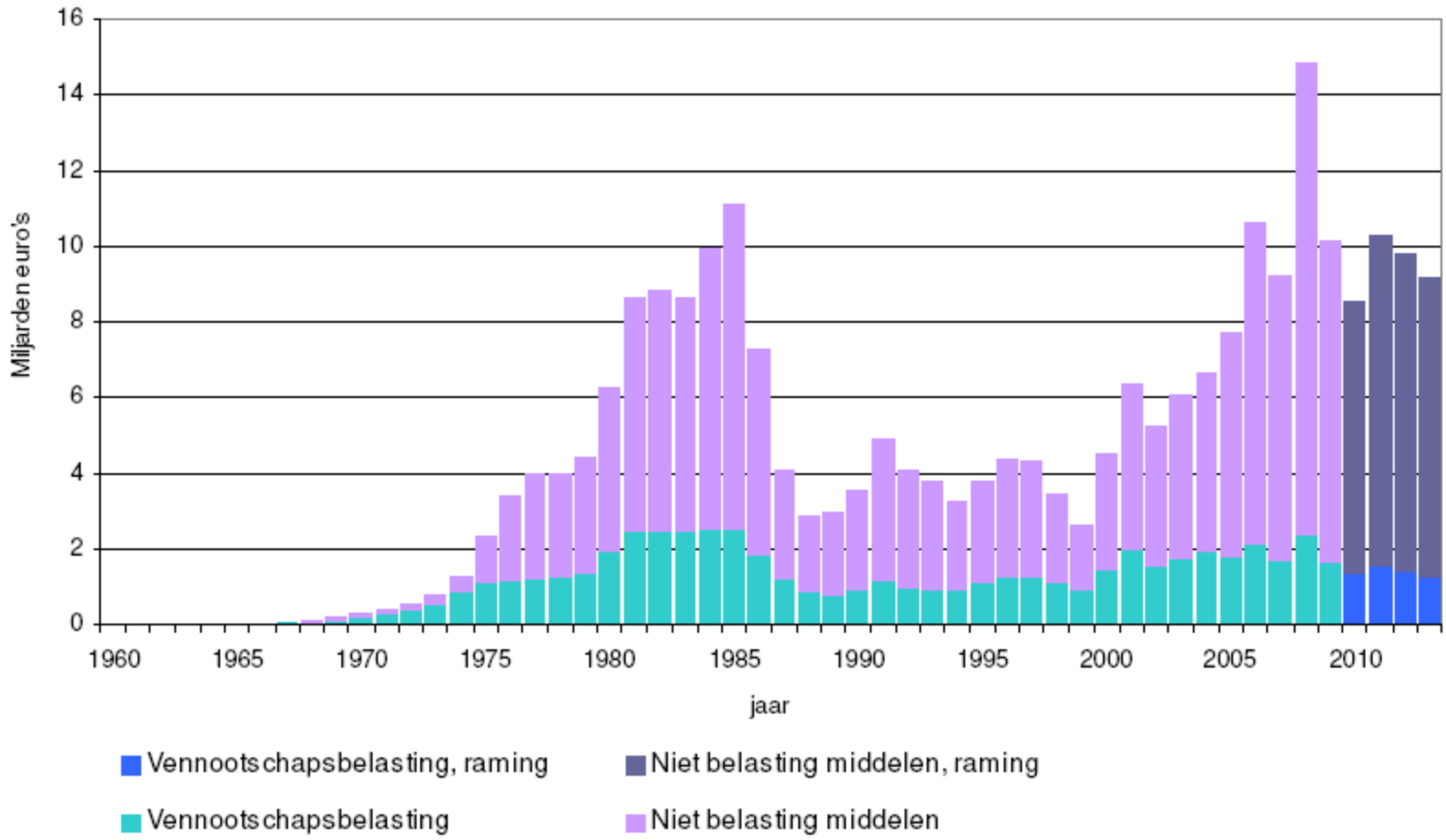
Exporters	mcm
Russia	191 892
Canada	106 988
Norway	85 136
Algeria	62 676
Netherlands	55 666
Turkmenistan	51 064
Qatar	38 329
Indonesia	33 554
Malaysia	32 039
United States	22 905
Rest of the world	219 939
World	900 188

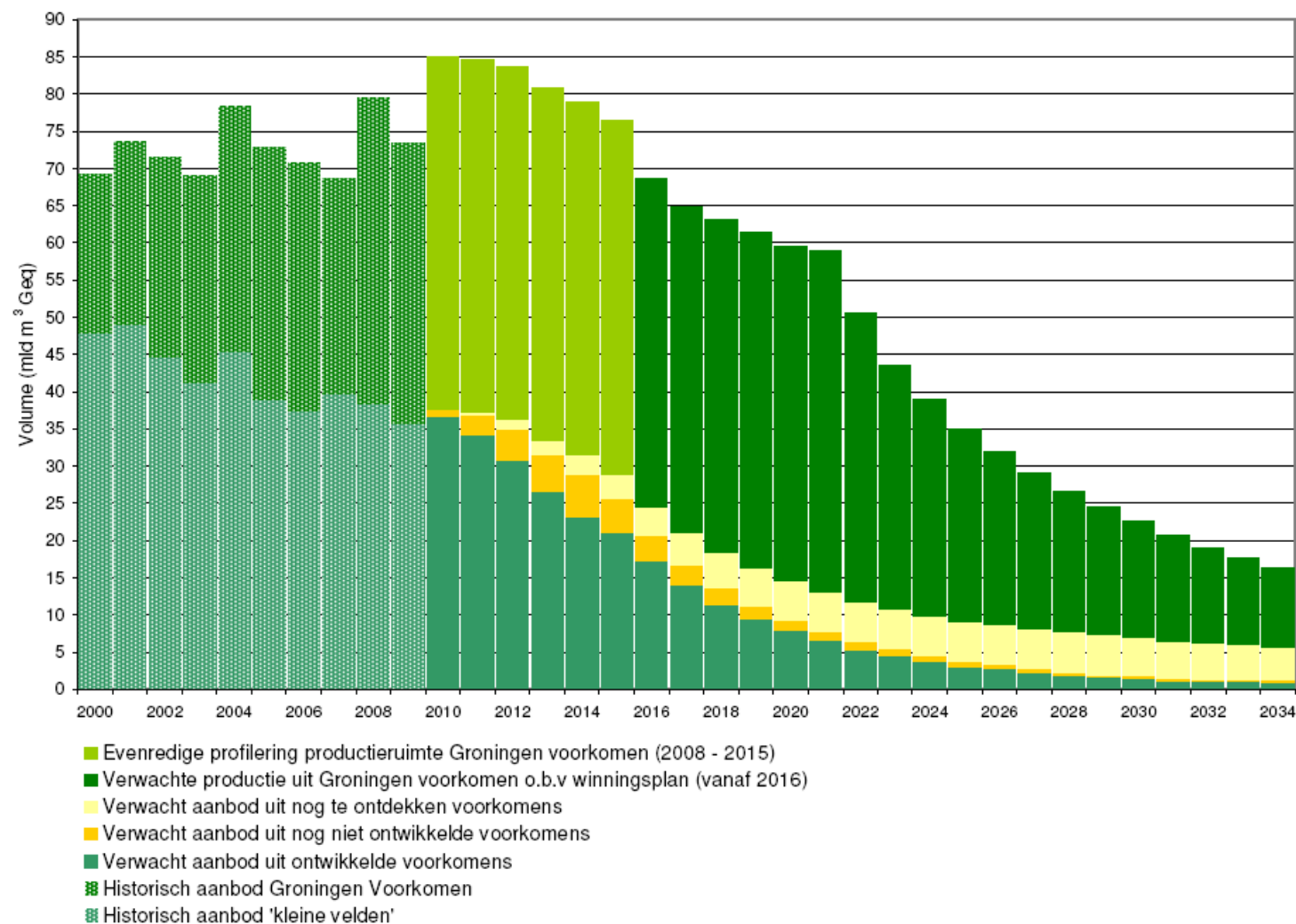
2007 data

Importers	mcm
United States	130 300
Japan	95 627
Germany	88 355
Italy	73 950
Ukraine	50 087
France	42 902
Turkey	35 832
Spain	34 474
Korea	33 385
United Kingdom	30 837
Rest of the world	283 334
World	899 083

2007 data

Aardgasbaten, 1960 – 2014





Figuur 2. Gerealiseerde productie van aardgas in Nederland van 2000 -2009 en de productieprognose voor de periode van 2010 – 2034.

2. Olie

Naast gas ook beetje olie!

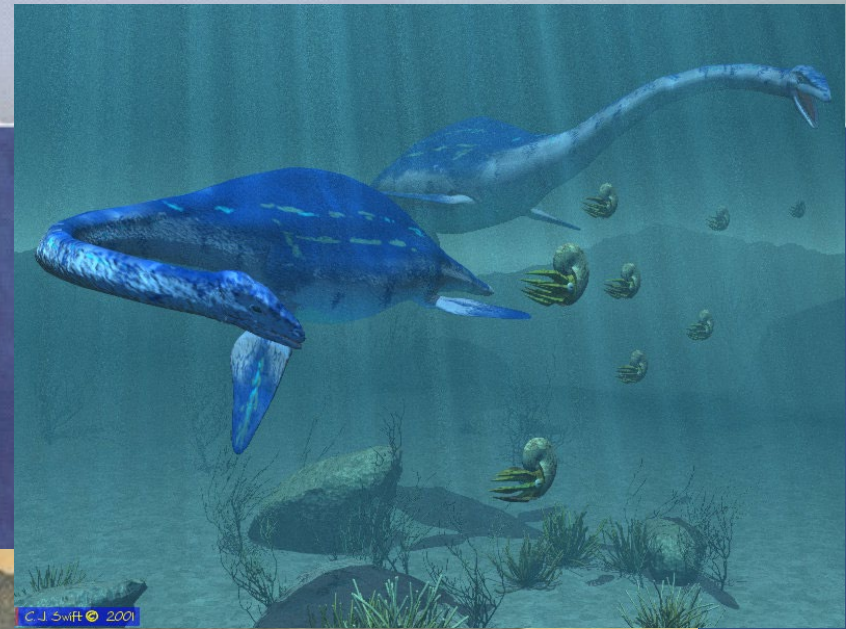


Warme zee

2. Olie

Moedergesteente:
Posidonia schalie
uit vroeg Jura

Veel dierlijke
resten: olie!



Delta's

2. Olie

Reservoir gesteente:
Jura en Krijt schalie en zandsteen
(oude delta's)

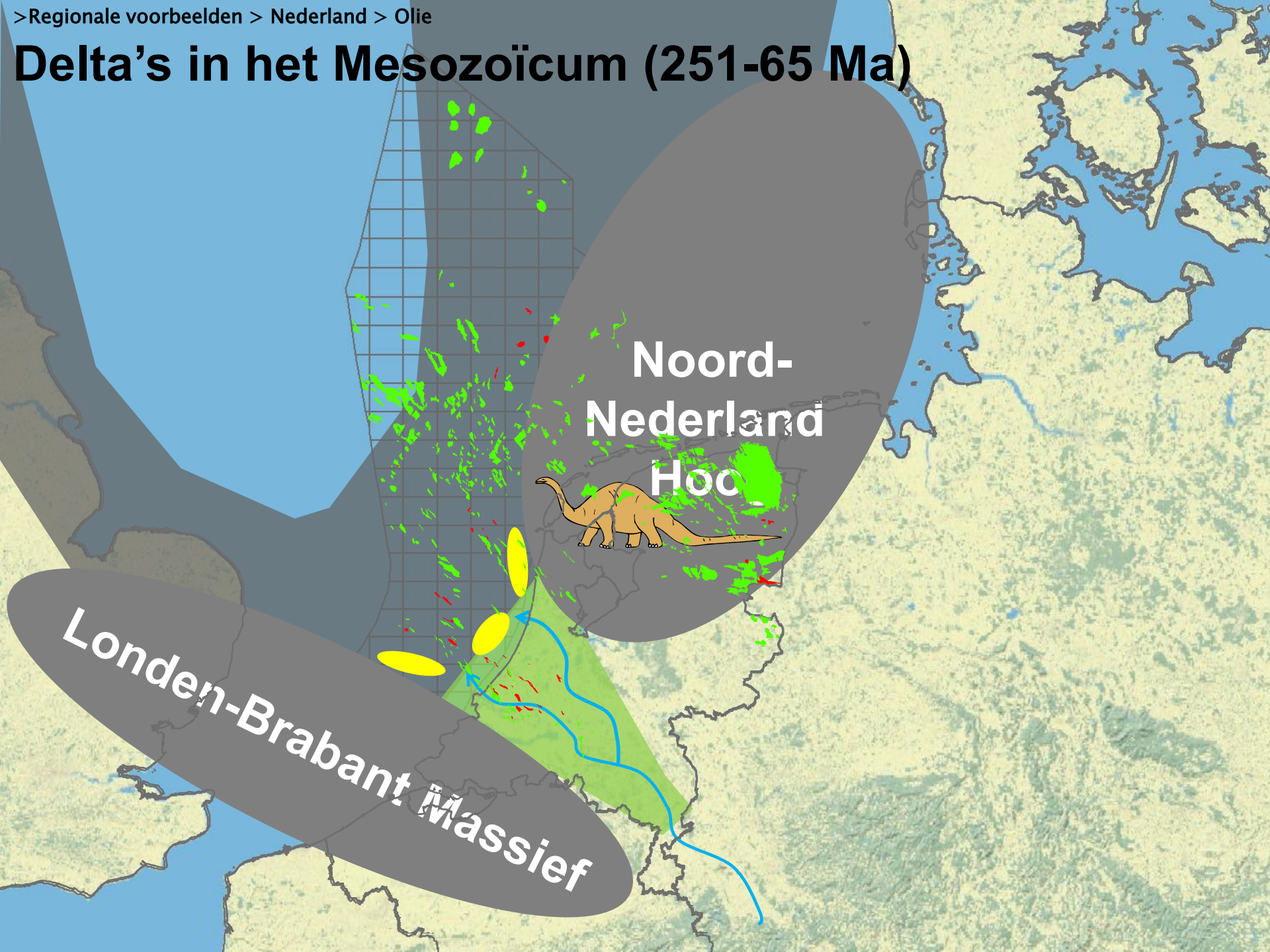


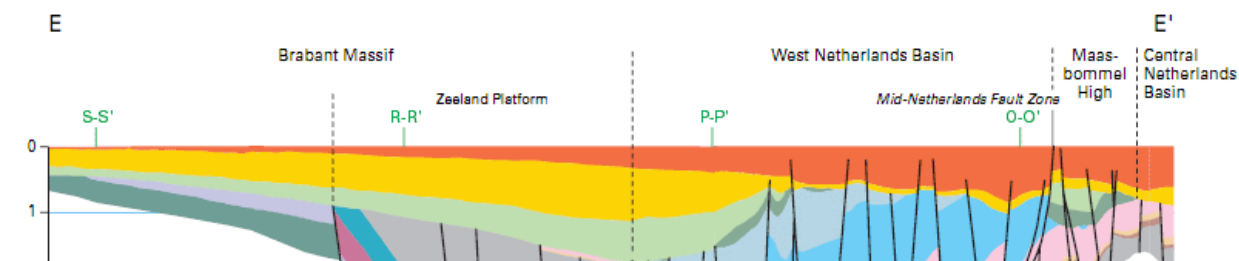
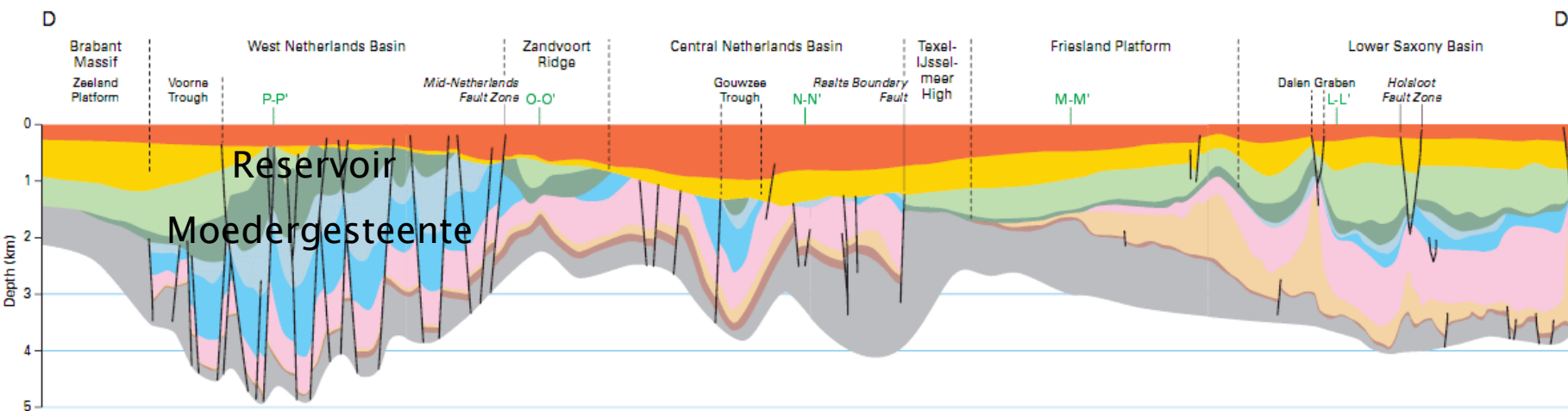
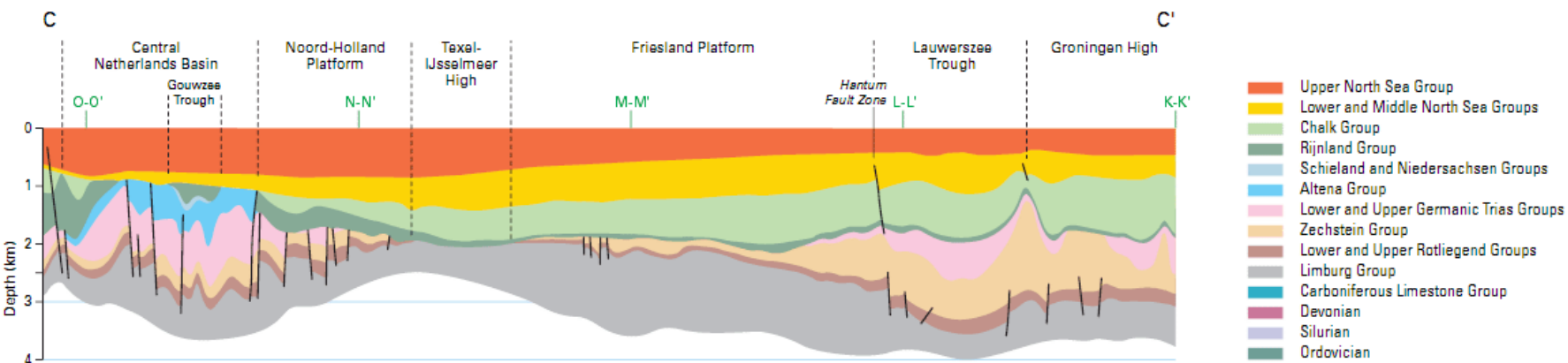
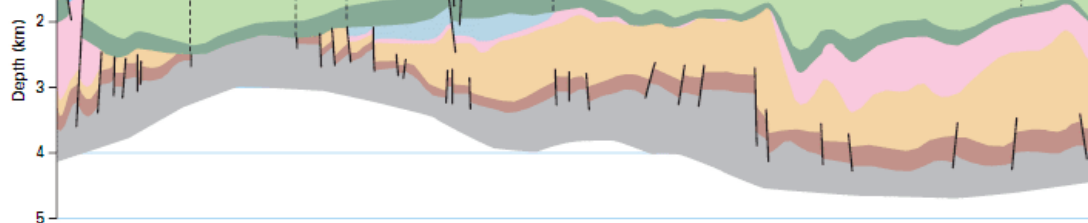
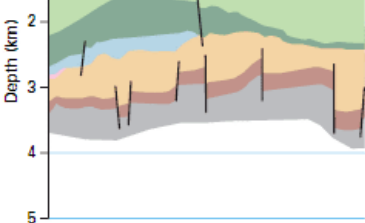
Photograph by Annie Griffiths Belt

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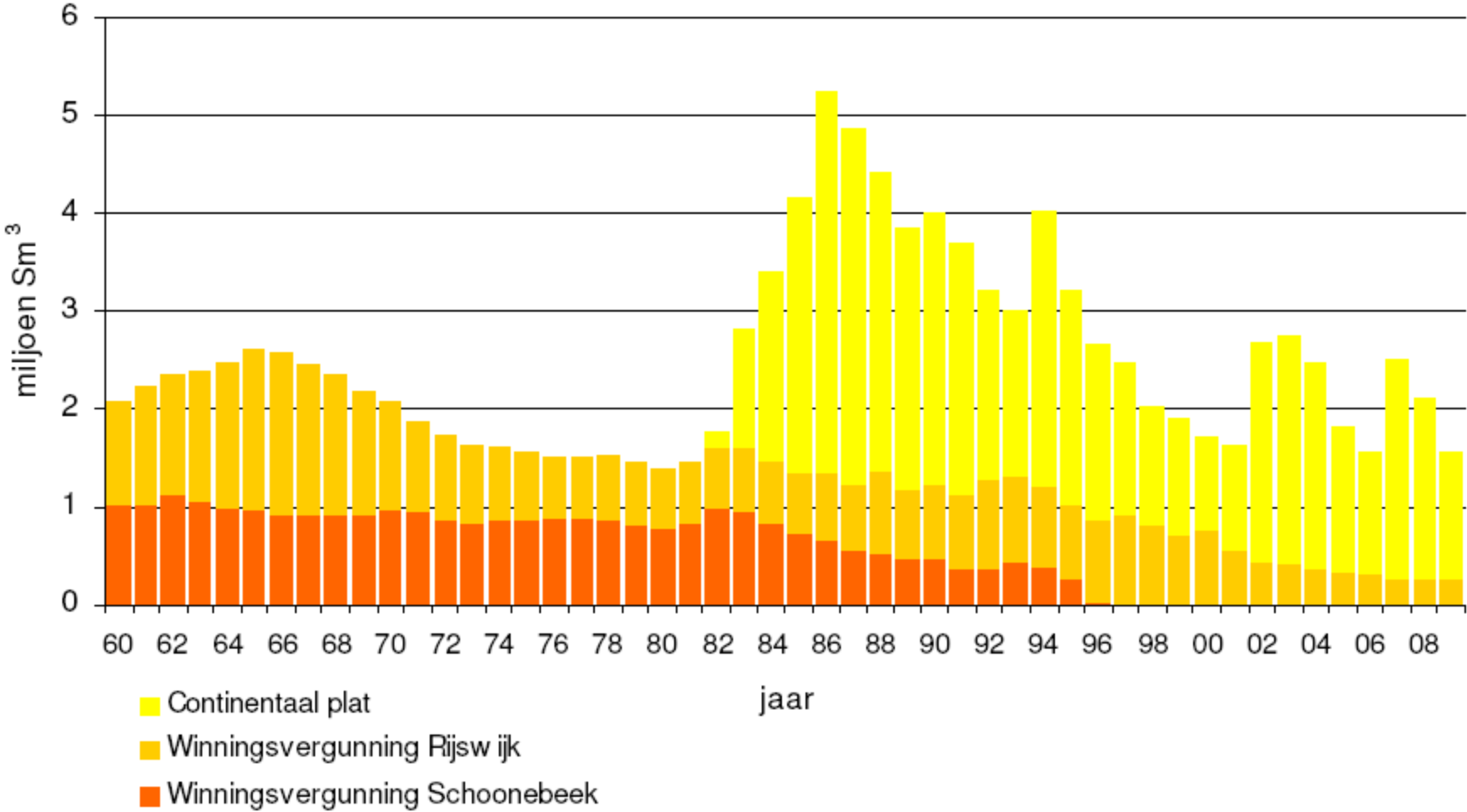
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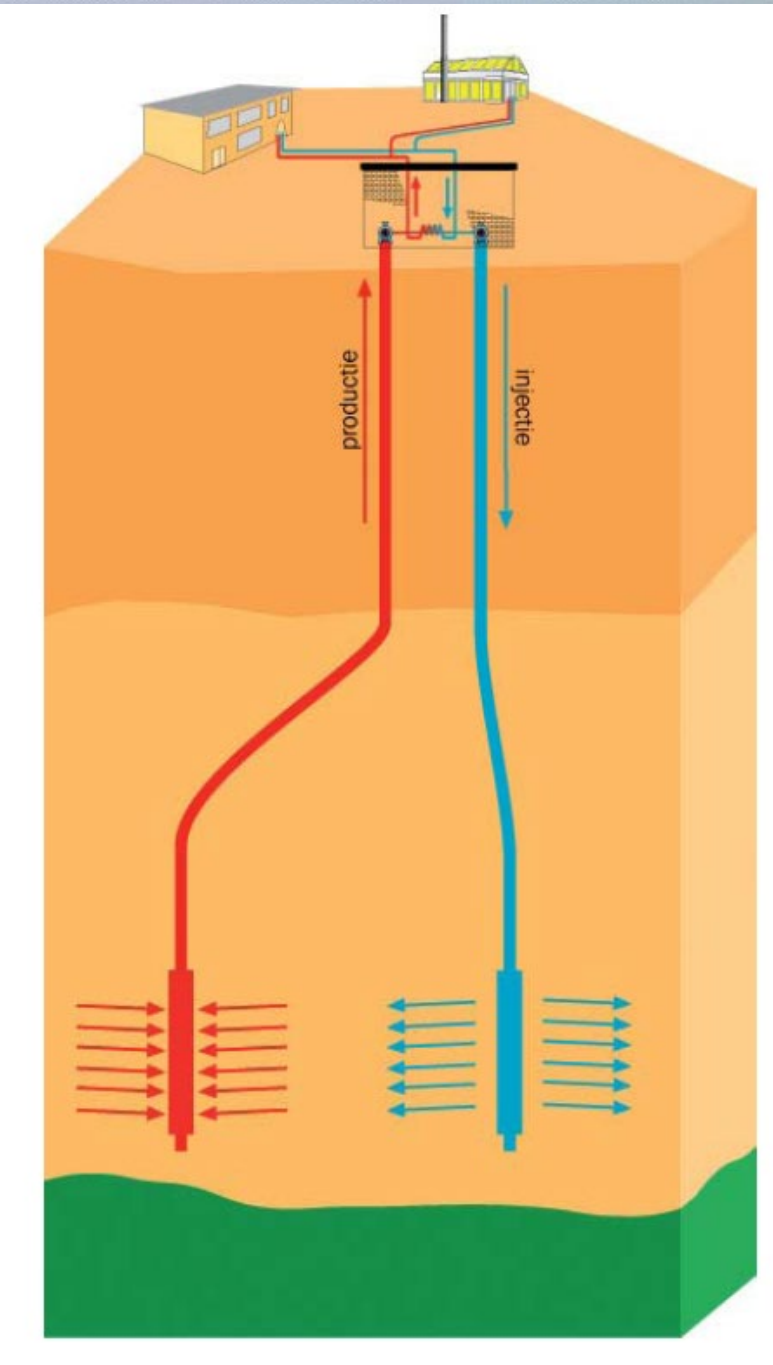
Delta's in het Mesozoïcum (251-65 Ma)





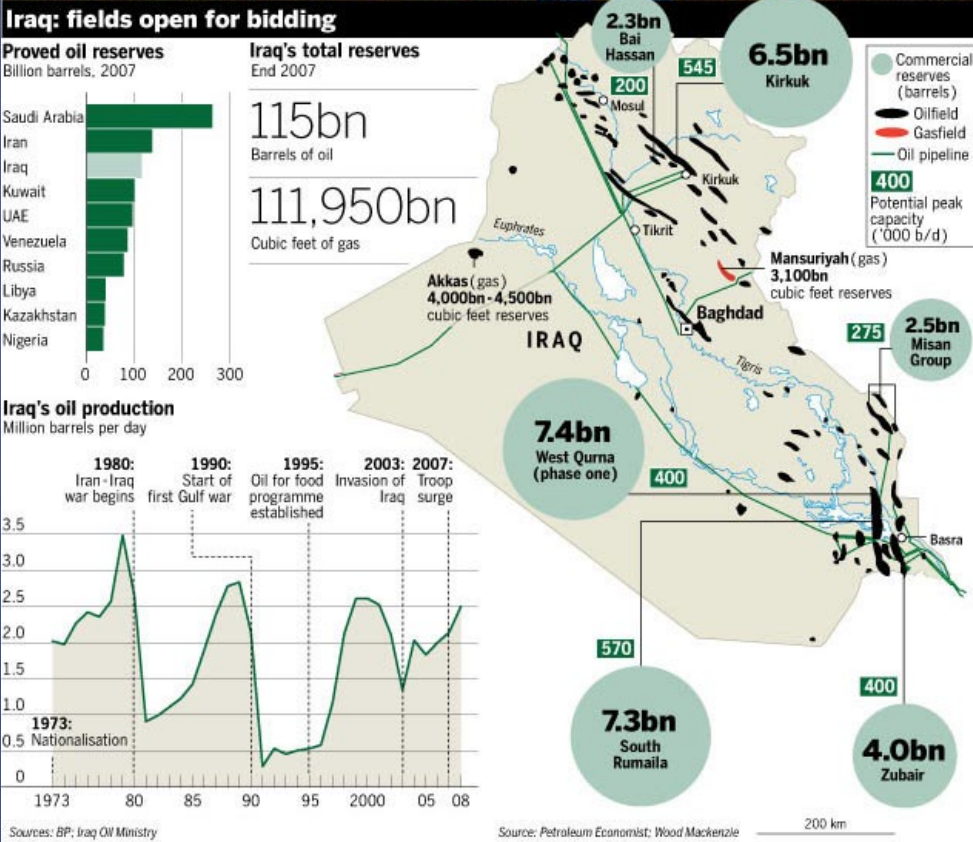
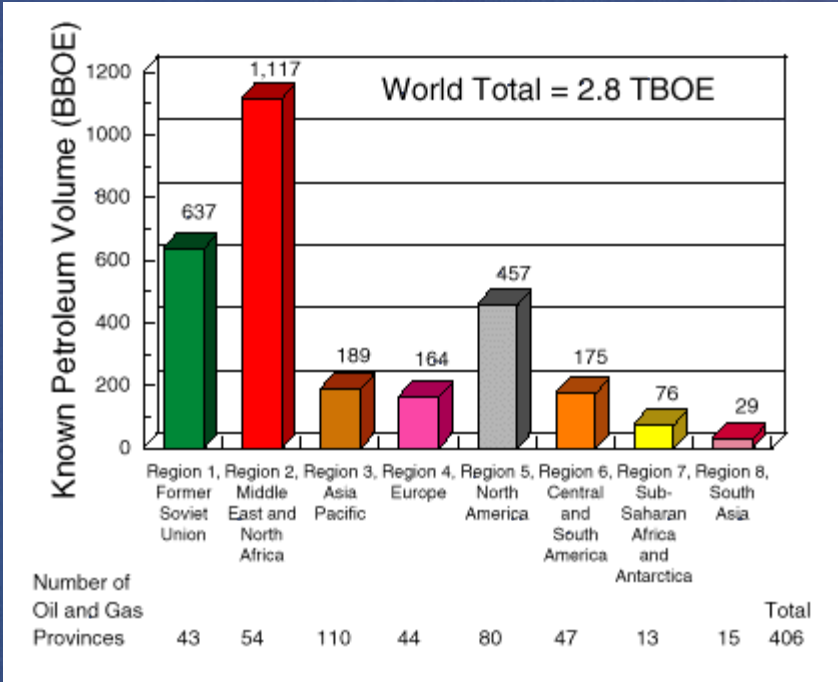
Aardolieproductie 1960 - 2009



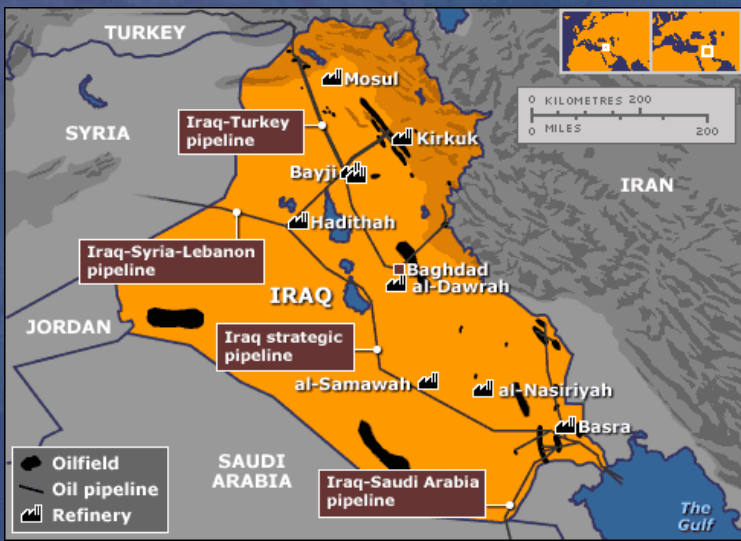
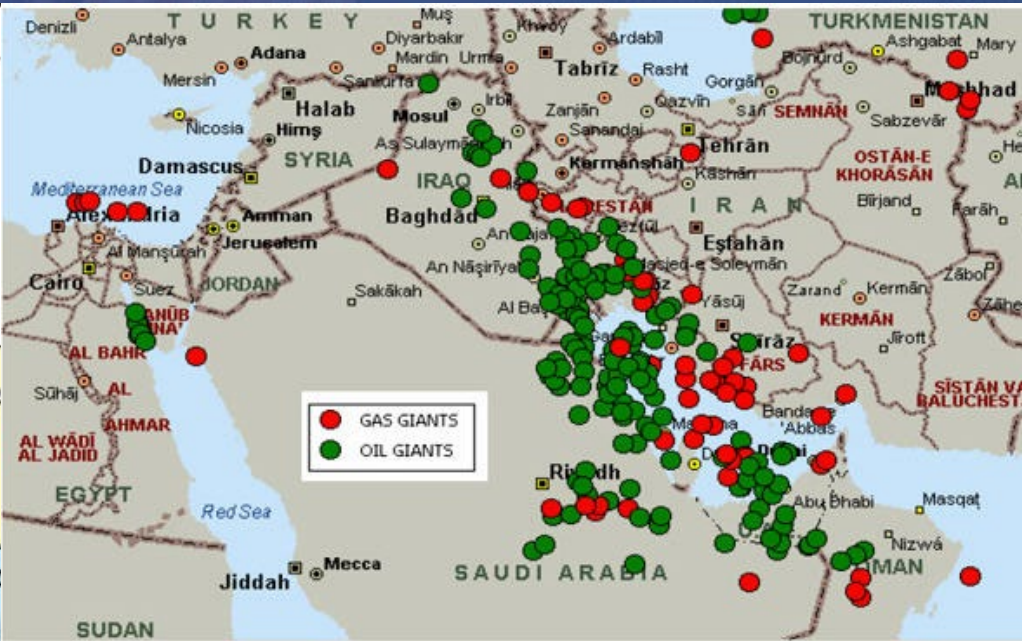


Regionale voorbeelden

2. Midden-oosten



Olie-grootmachten!



Hoe komt al die olie daar?



Moedergesteente



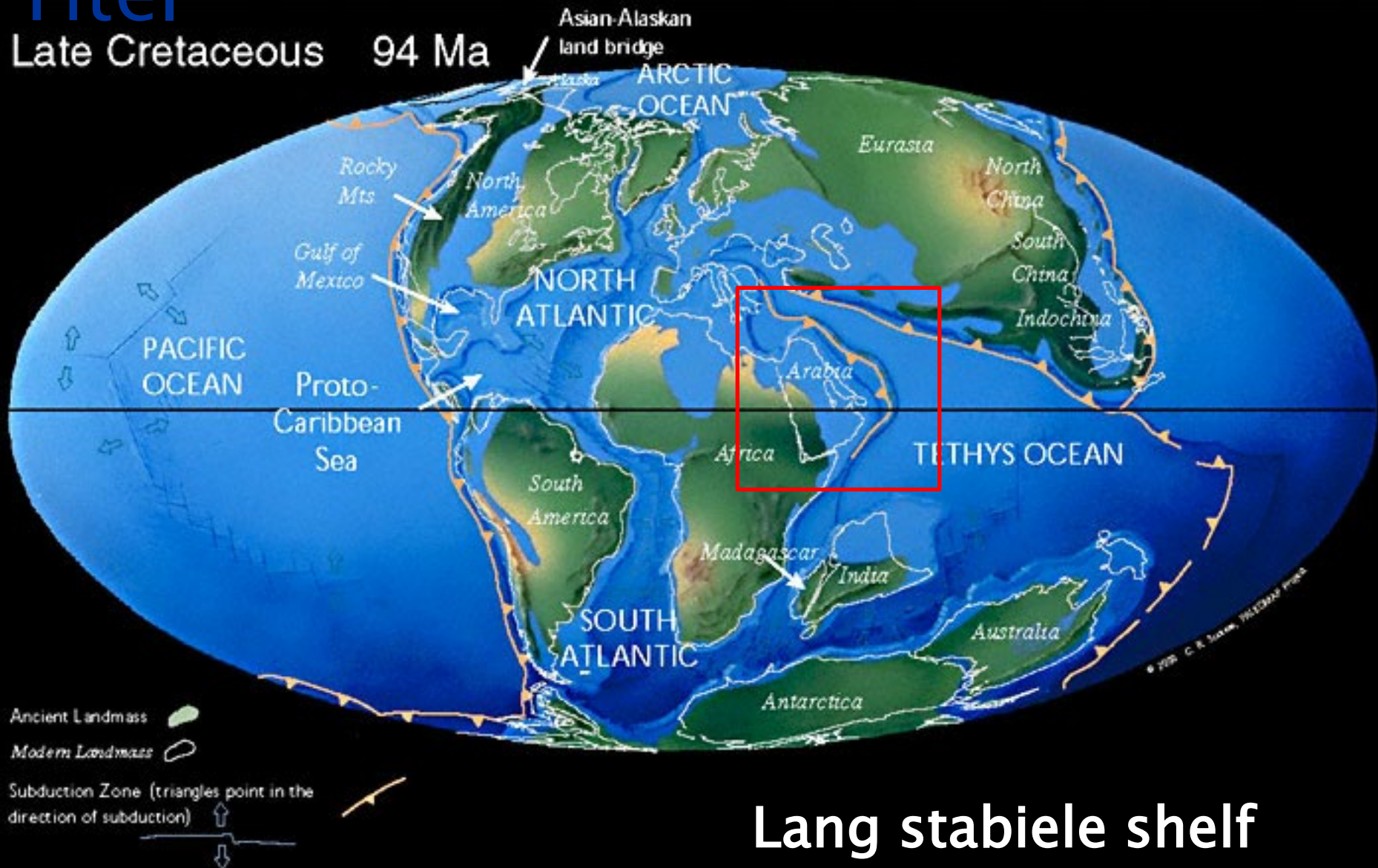
Late Jurassic 152 Ma



Lang stabiele shelf

Titel

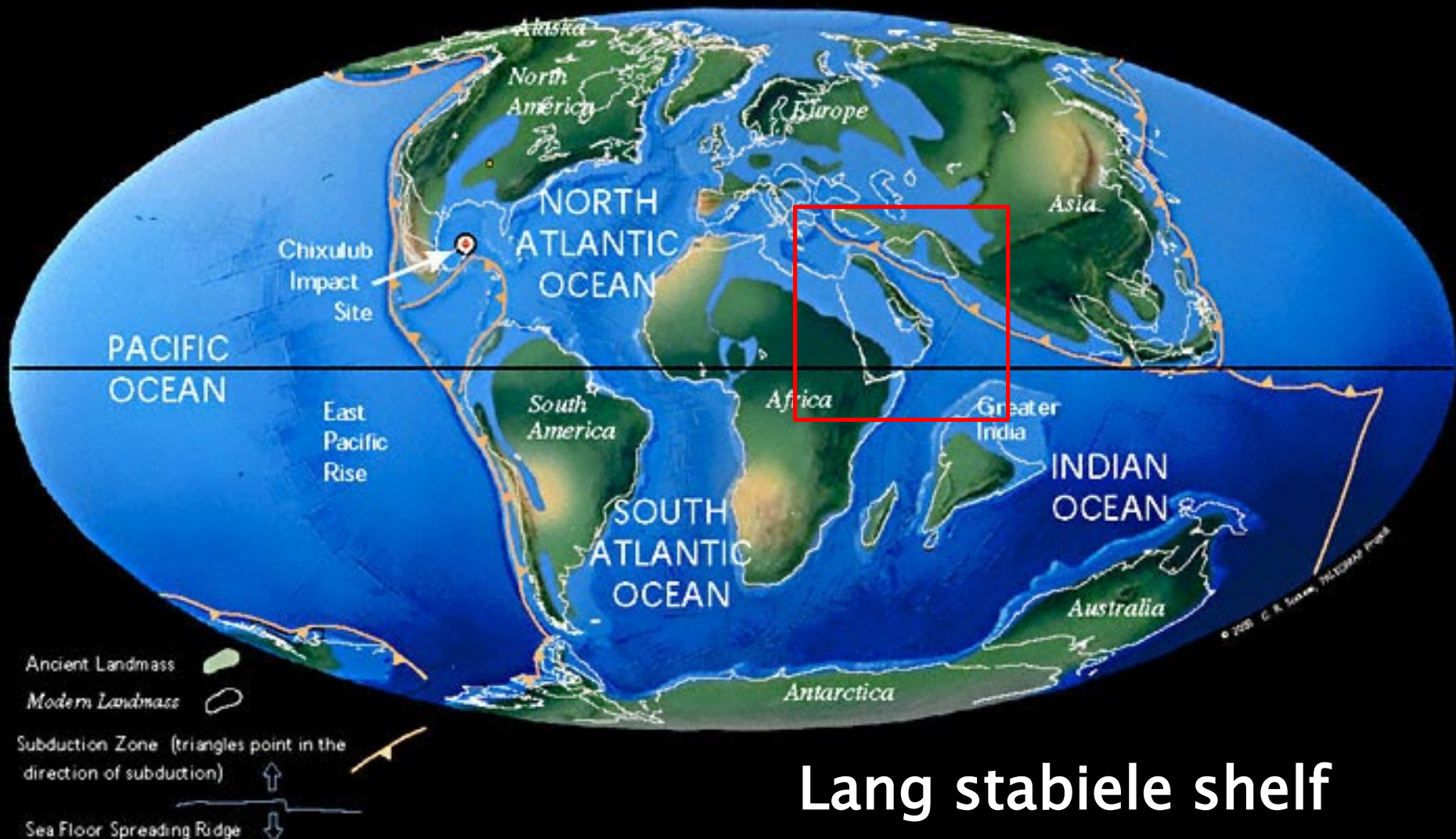
Late Cretaceous 94 Ma



Lang stabiele shelf

Titel

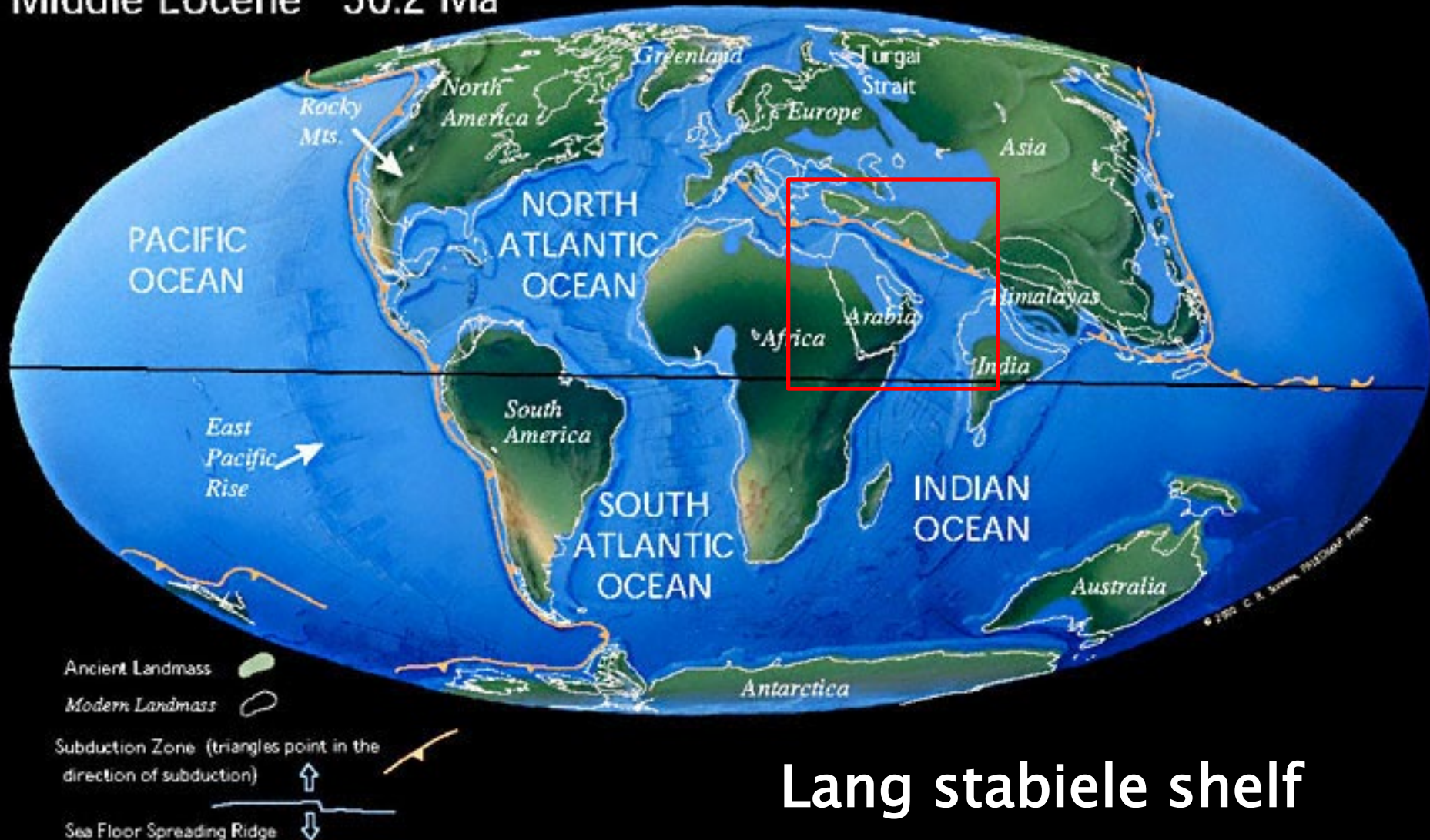
K/T Boundary 66 Ma



Lang stabiele shelf

Titel

Middle Eocene 50.2 Ma



Lang stabiele shelf

Titel

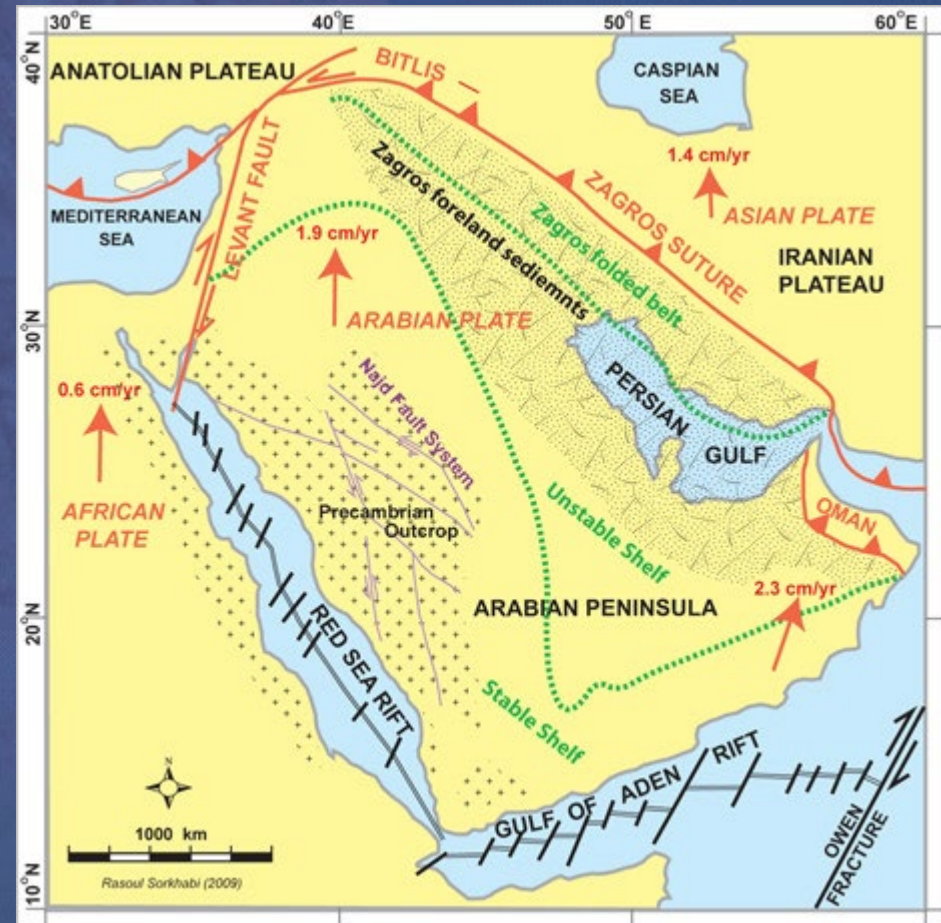
Middle Miocene 14 Ma



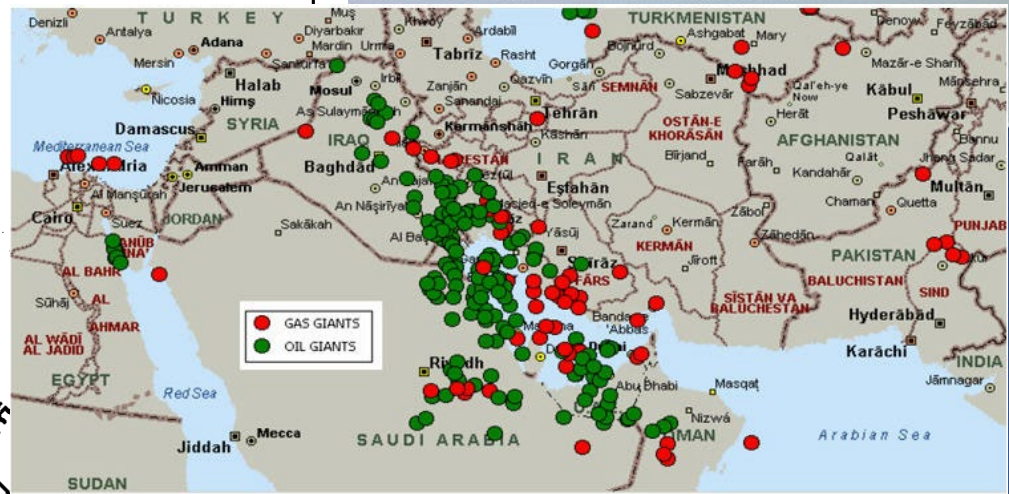
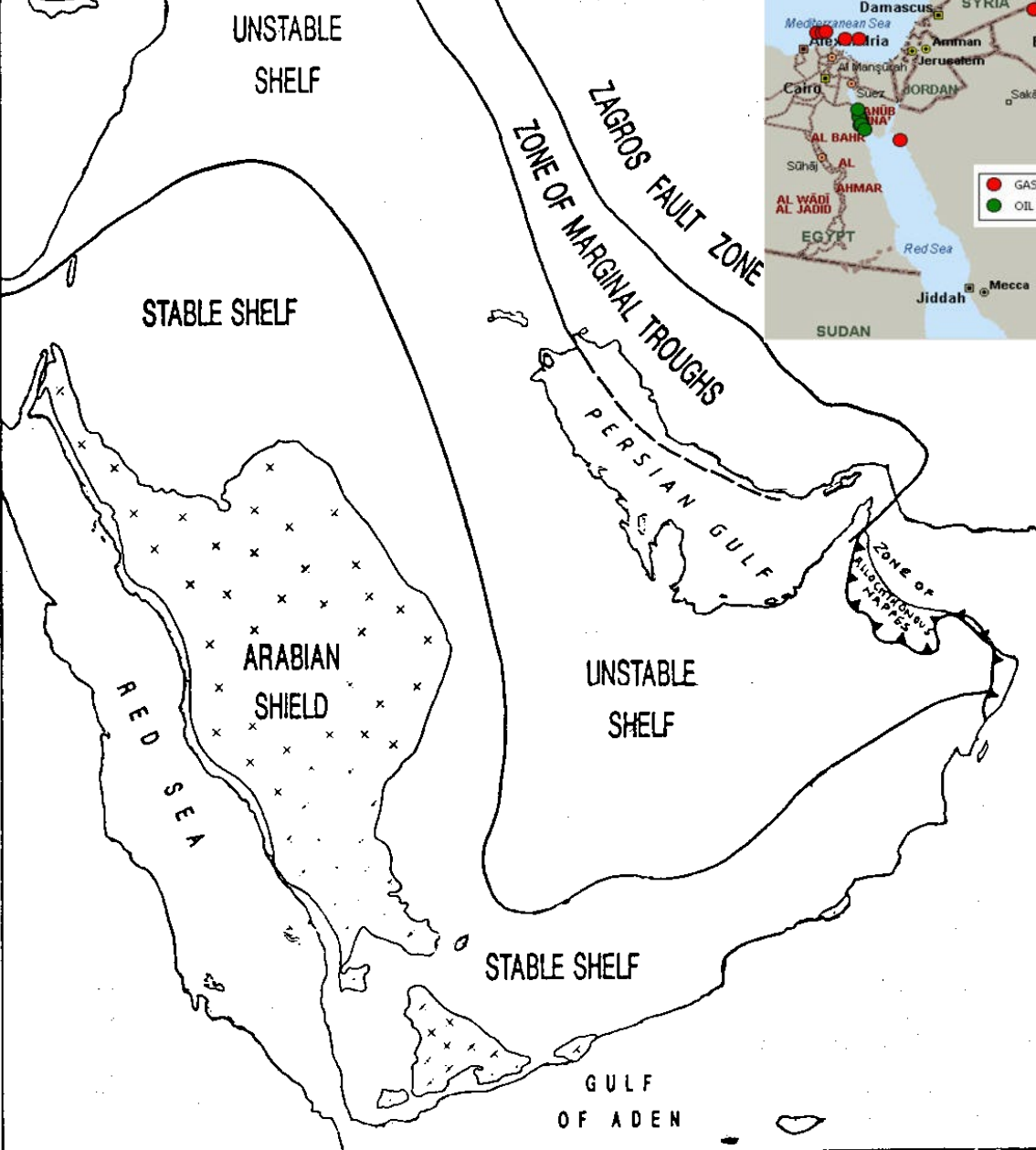
Lang stabiele shelf

Botsing!

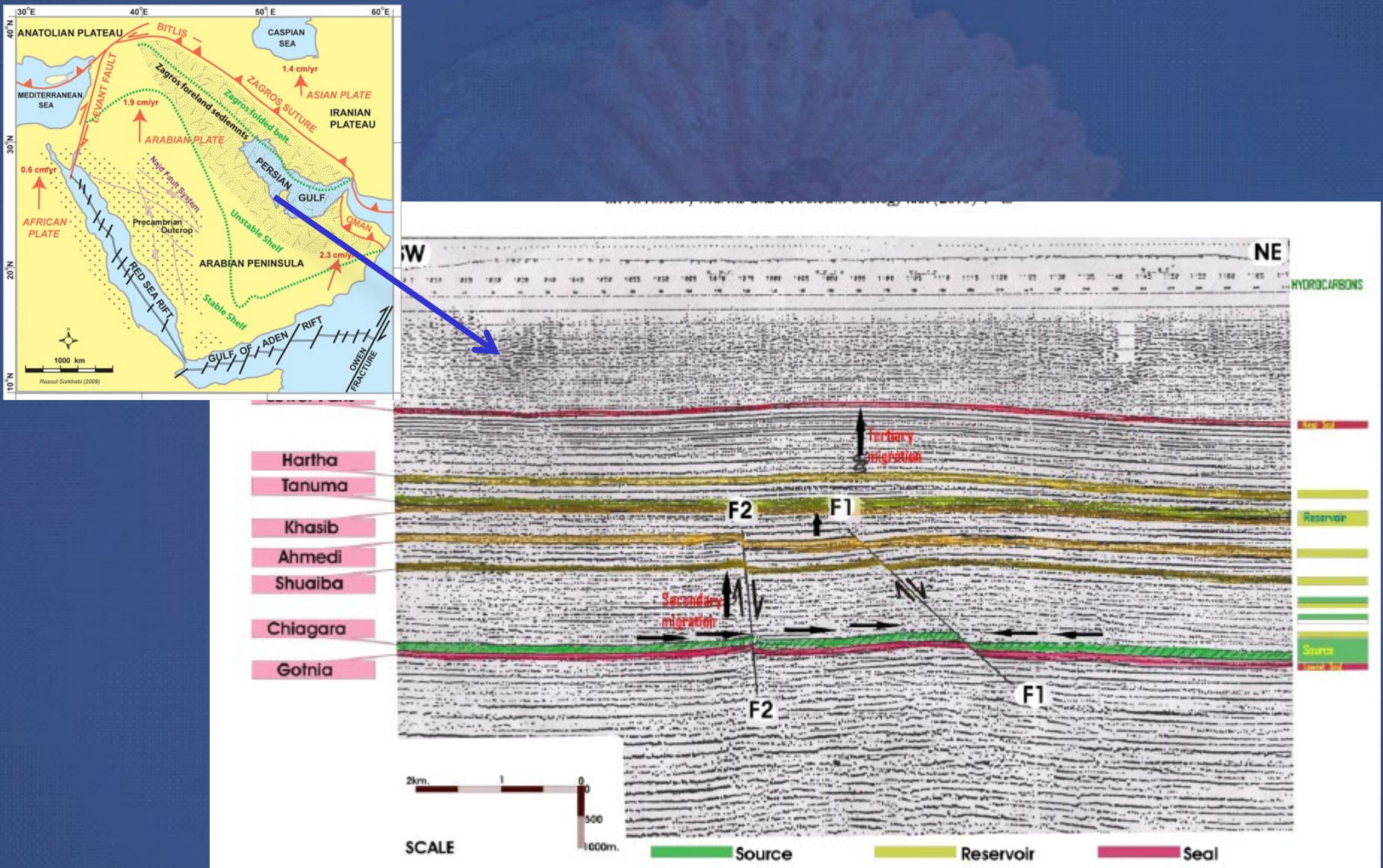
Vervorming:
Vooral langs de rand



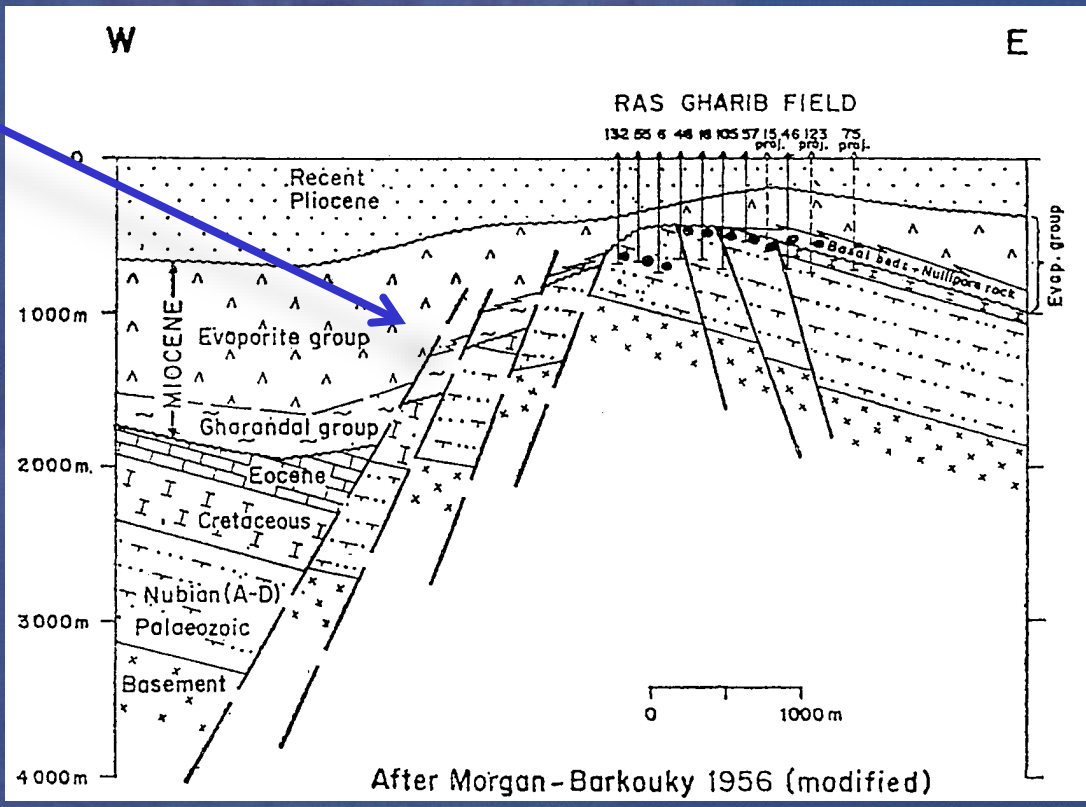
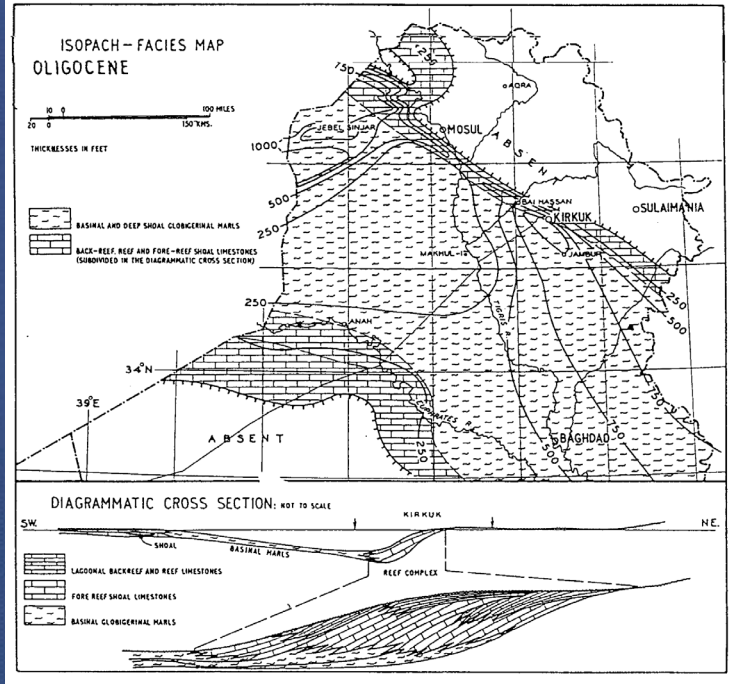
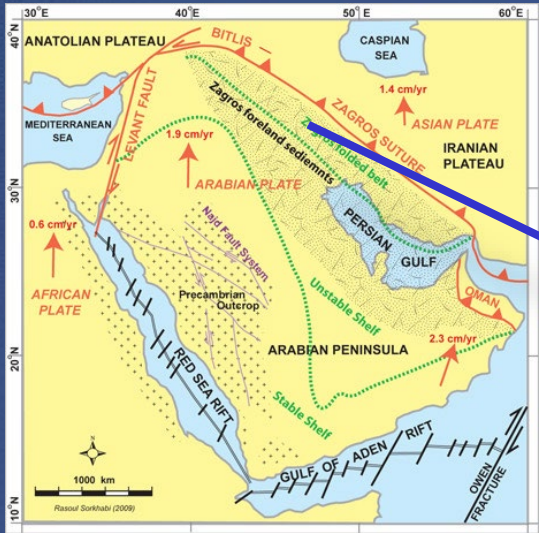
Overeenkomst!



Centrale deel



In botsing



Bijzonderheden

- niet echt dikke of rijke moedergesteente
- vooral grote en subtiele structuren (sommigen meer dan 1000km²)
- hierdoor ook weinig verlies door fracturing
- horizontaal erg efficiënte migratie, want facies zeer homogeen.



Producers	Mt	% of world total
Russia	487	12.4
Saudi Arabia	483	12.3
United States	310	7.9
Islamic Rep. of Iran	218	5.5
People's Rep. of China	188	4.8
Mexico	173	4.4
Canada	157	4.0
Venezuela	138	3.5
Kuwait	136	3.5
United Arab Emirates	131	3.3
Rest of the world	1 516	38.4
World	3 937	100.0

2007 data

Exporters	Mt
Saudi Arabia	358
Russia	248
Islamic Rep. of Iran	130
Nigeria	119
Norway	109
United Arab Emirates	106
Mexico	99
Canada	93
Venezuela	89
Kuwait	88
Rest of the world	764
World	2 203

2006 data

Importers	Mt
United States	587
Japan	203
People's Rep. of China	145
Korea	120
India	111
Germany	110
Italy	94
France	82
Spain	61
United Kingdom	59
Rest of the world	713
World	2 285

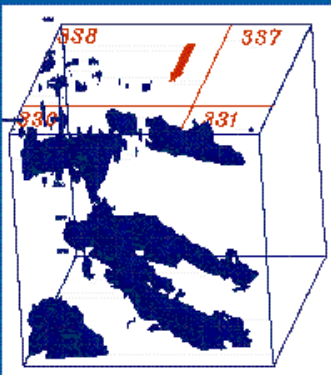
2006 data

**Includes crude oil, NGL, feedstocks, additives and other hydrocarbons.*

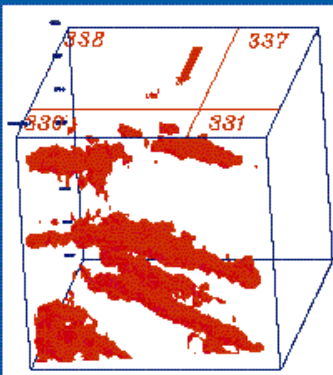
4D: in tijd!

4D is Multiple 3D

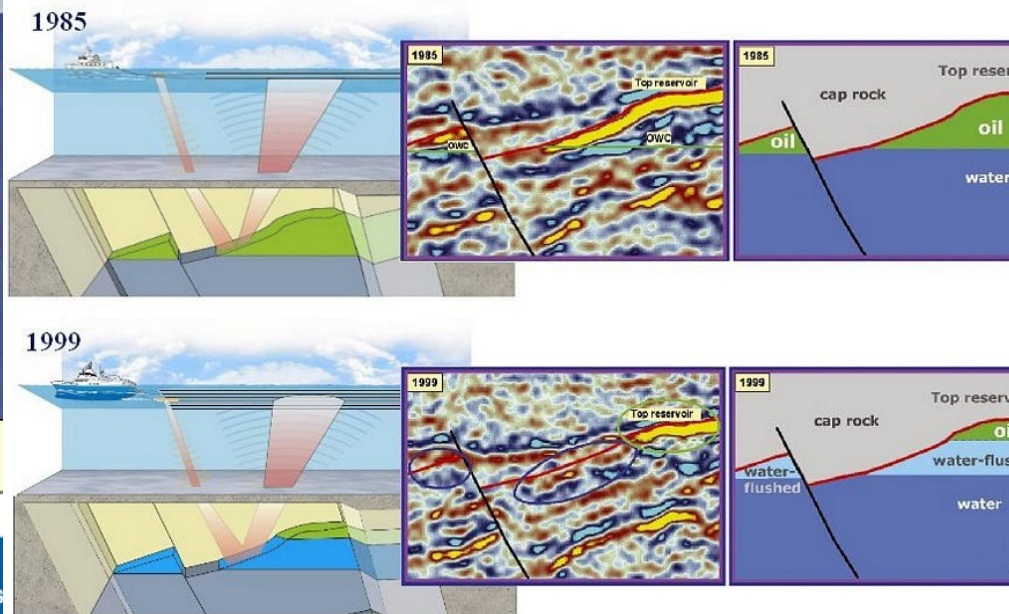
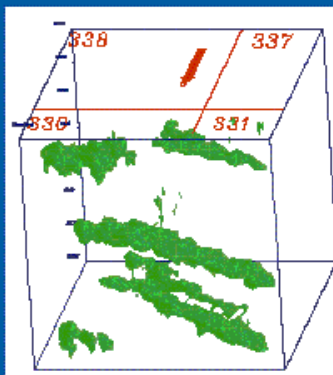
Isosurface of the
PENNZOIL (1985) survey



Isosurface of the
TEXACO (1988) survey



Isosurface of the
SHELL (1992) survey

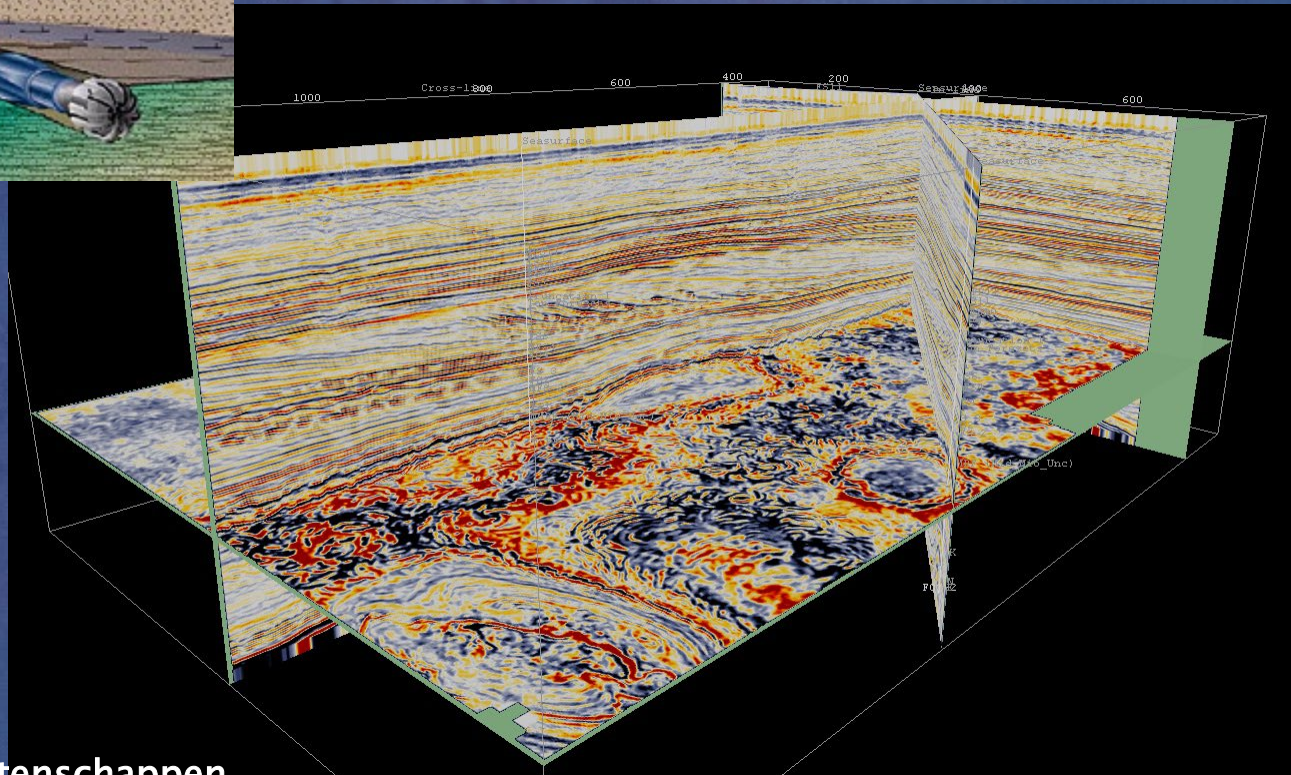
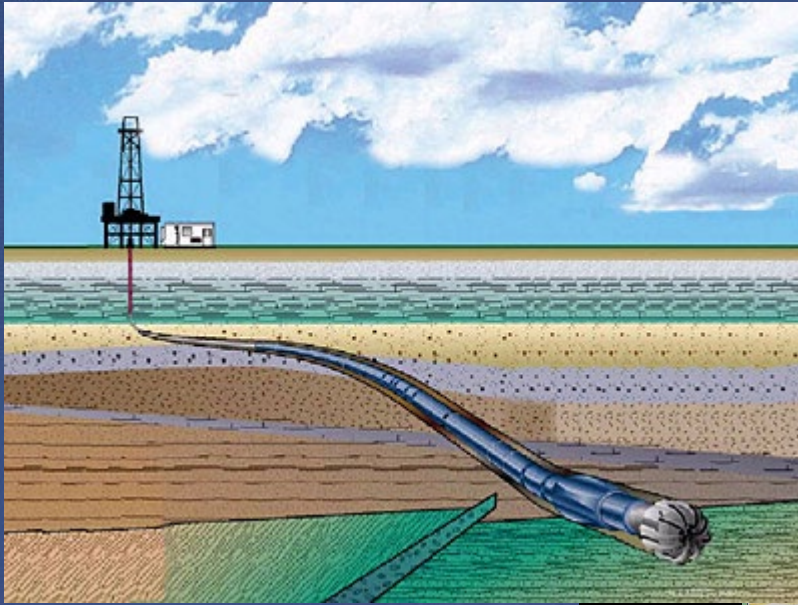


In blue, are the amplitude envelopes surrounding producing reservoirs in the Eugene Island Block 330 field as they appeared in 1985 from a 3D seismic survey acquired by Pennzoil, Mobil and BP.

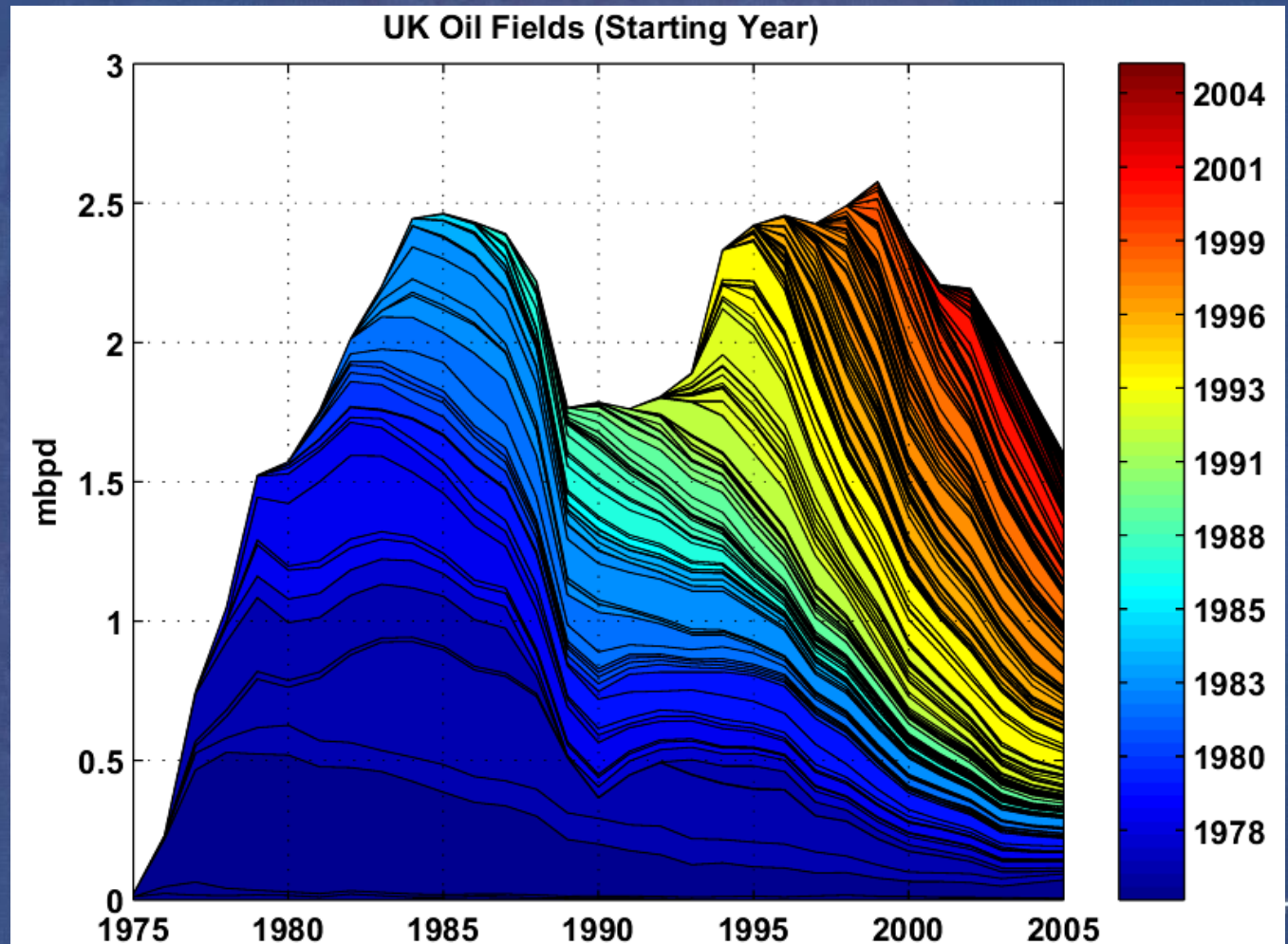
In red, are the same reservoirs imaged by a 3D survey acquired by Texaco and Chevron in 1988. Improved technology has lowered the noise and raised the high frequency components of the images

In green, a third 3D survey was shot by Shell and Exxon in 1992. Notice the clear shrinkage in size of each reservoir and the noise-free definition of the bounds of each reservoir.

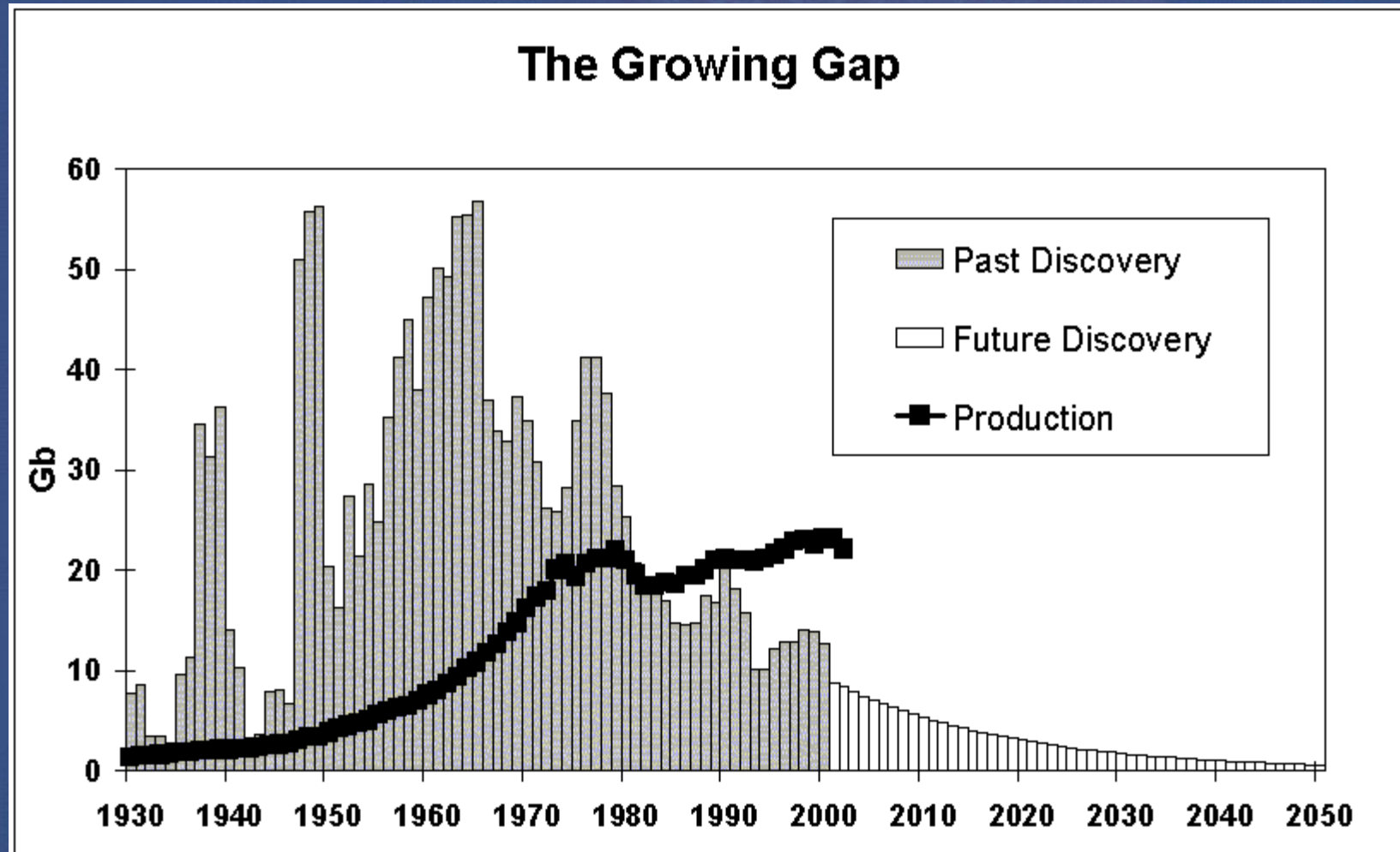
Nieuwe technieken



Veel nieuwe ontdekkingen



Maar niet genoeg?



Meer informatie?

<http://www.nlog.nl>

Nederlandse Olie en gas portal

Delfstoffen en aardwarmte in Nederland
Jaarverslag 2009, ministerie van
economische zaken

www.falw.vu.nl/docenten

Bij KNAGdag 2010 staat deze presentatie!